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The Nation's Range Resources

A FOREST-RANGE ENVIRONMENTAL STUDY

Forest Resource Report No. 19

Forest Service

U.S. Department of Agriculture

This is one of four reports that present the concepts, procedures, information, and analyses developed in the Forest-Range Environmental Study (FRES), Forest Service, U.S. Department of Agriculture, 1970–1972.

The basic document is:

- *The Nation's Range Resources—a Forest-Range Environmental Study.* This report presents basic concepts and methods, information on supply and demand for resources from all the Nation's forest-range environment, and analyses of alternative mixtures of resource use.

Supporting *The Nation's Range Resources—a Forest-Range Environmental Study* are:

- *Forest-Range Environmental Production Analytical System (FREPAS),* the analytical and computer capability developed for FRES.
- *Vegetation and Environmental Features of Forest and Range Ecosystems,* a system of classifying all the land area of the 48 contiguous States into 34 units called "ecosystems," and a description of each.
- *Range Management Practices: Investment Costs,* 1970. Definitions of the 18 range management practices used in the Forest-Range Environmental Study (FRES) and lists of investment costs for each practice in each of 956 resource units of forest-range found within 34 major ecosystems.

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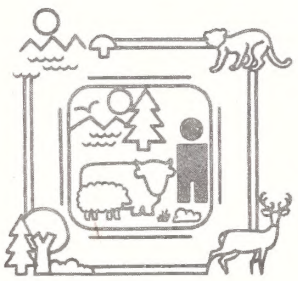

The cover design symbolizes the interrelationship of organisms and their environment and the sun —the moving force without which life could not exist. Plants and animals all work together within an ecological system, an ecosystem.

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The Nation's Range Resources—
A Forest-Range Environmental Study

by

Forest-Range Task Force

Forest Resource Report No. 19

December 1972

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ACKNOWLEDGMENTS

The Forest-Range Environmental Study was a major Agency effort. It involved personnel from each of the nine Forest Service administrative regions, the eight Forest and Range Experiment Stations, and the two State and Private Forestry Areas, in addition to many headquarters office personnel. Because of the multi-resource flavor, professionals from many scientific and administrative disciplines contributed. Among the many disciplines represented were: forestry, range, ecology, watershed, hydrology, soils, economics, recreation, landscape architecture, and computer science. A Forest-Range Task Force consisting of a representative from each of the three major Forest Service program areas—National Forest System, State and Private Forestry, and Research—directed the study.

However, Federal agencies in addition to the Forest Service participated in the study. Furnishing data and advice were: Bureau of Land Management, National Park Service, Fish and Wildlife Service, and Bureau of Indian Affairs of the Department of the Interior; and Economic Research, Soil Conservation Service, and Agricultural Stabilization and Conservation Service of the U.S. Department of Agriculture.

The study effort required new analytical approaches involving systems analysis and computer capability. The necessary capability was developed under a cooperative program with the Economic Research Service of USDA and the University of Nebraska Computing Center.

To individually name here the contributors who invested heavily of their time and energies would do disservice to many others, some of whose contributions, though of short duration, provided conceptual breakthrough. The Forest-Range Task Force, however, wishes to recognize here the significant contributions of Melvin D. Bellinger, Gilbert Duran, Jr., Vinson L. Duvall, H. Fred Kaiser, Clark Row, Dixie Smith, and David Worley, Forest Service, and John Putman, Economic Research Service. These individuals served as a working group throughout the Study. Others who participated are listed on page 147. The sustained productive contributions of fellow Task Force member, R. Z. Callaham, Forest Service, greatly facilitated completion of the Study.

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Abstract

Forest-Range Task Force

1972. The Nation's Range Resources—A Forest-Range Environmental Study. Forest Resource Report No. 19, USDA Forest Service, Washington, D.C., 147 pp., illus.

A system was developed for categorizing the forest and range area of the 48 conterminous United States into major ecosystems. These ecosystems were divided according to ownership, productivity, and condition into resource units, land area determined, and 1970 grazing production and 21 other outputs estimated. Yield of all outputs in each of 956 resource units was estimated under six simulated levels of management. Demand was derived for livestock grazing and estimated for other forest-range outputs. An analytical system was developed with a minimum cost objective function and used to suggest management mixes to achieve national goals for forest-range livestock production at minimum cost when modified by environmental or social considerations. Policy alternatives for meeting long-run policy objectives were evaluated and conclusions drawn about forest-range grazing.

Keywords: Forest and range ecosystems, ecosystem classification, multi-resource planning, resource allocation model, resource decision alternatives.

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SUMMARY

A systems study was designed to explore the current (1970) and prospective production of resources and role of grazing on all forest and range ecosystems—the forest-range—of the 48 conterminous United States. This report presents the concepts and procedures developed, information assembled, and policy alternatives evaluated.

All of the 1.2 billion acres determined to be forest-range was categorized into 34 major ecosystems. Using ownership, productivity, and condition, each ecosystem was divided into resource units. Current (1970) production of animal unit months (AUM's) of grazing and of 21 associated resource outputs was estimated for each of 956 resource units. Six management strategies were developed for each resource unit. Each strategy consisted of a package of conventional range management practices that were believed necessary to attain the objective of the strategy. Costs for each strategy were derived for each resource unit. Then, each management strategy was applied by simulation to each resource unit, and production of all 22 resource outputs was estimated. Demand for forest-range grazing was determined, and estimates of other demands on the environment were assembled from other studies.

An analytical system was developed and made operational that relates demands to available resources in determining the mix of inputs required to achieve a desired mix of outputs. The system not only permits assessment of demands, but also measurement of resource productive capacity and trade-offs between outputs. It contains accounting systems to handle the mass of resource and cost data and a linear programming code capable of accepting a variety of external constraints.

Using the assembled information and the analytical system, many alternatives were constructed and evaluated for producing animal unit months of forest-range grazing at minimum cost for different target levels under selected political, social, environmental, and economic constraints. Selected alternatives are presented.

It is generally concluded that forest-range grazing will continue to provide a share of total national needs for livestock feed. While the forest-range resource has additional grazing potential in some areas, in other areas it is overdeveloped or is being improperly grazed. Thus, investment costs to produce an animal unit month of grazing vary greatly, and much inefficiency exists in the allocation of land to forest-range grazing. Since most of the forest-range environment is not Federally owned, where this study found considerable exploitative grazing, the major grazing impacts on environmental quality will depend upon how non-Federally owned forest-range is managed. Management programs, however, can be developed that will result in more efficient use of the forest-range for grazing and will also enhance environmental quality.

INTRODUCTION

Increasing ecological awareness, changing views about economic growth as an indicator of national well-being, and at the same time, a well-documented need for more goods and services, present a paradox. How can modern Man satisfy his expanding desires? How can he have his "ecology," his color-TV, his expanded highway system? How can he satisfy his basic needs, his luxury wants, and his aesthetics? To what degree can a finite world with limited resources provide these things?

Within the scope of these questions lies the origin of the Forest-Range Environmental Study (FRES) upon which this report is based.

STUDY OBJECTIVES AND SCOPE

The purpose of the Forest-Range Environmental Study was to assemble information about all of the Nation's range and to develop a technology for its evaluation that would serve the planning needs of the Forest Service. Needed was an orderly arrangement of management alternatives, each based upon an evaluation of information about the physical and biological resources of the environment. Social, political, and economic needs would also be considered.

Using the information and technology to be developed during the study, alternatives were to be prepared for setting future direction of Forest Service programs in range resource management. The focus of the study was to be on range within the total natural functioning ecosystem but with consideration of other resources and resource uses.

Originally the study was to cover the entire land base of the United States. However, only the 48 conterminous States could be studied because of time and personnel available, and the availability of resource information. Since "range" is intimately related to other "environments," and since a clear definition does not exist between range and pasture, and between range and forest and some other kinds of land with respect to grazing use, an arbitrary definition was made. All natural ecosystems that produce or can produce forage collectively were called "forest-range." Included in the study, therefore, are all range and all forest ecosystems of all ownerships in the 48 States. Not included are croplands, improved pastures, urban areas, transportation system lands, and areas of major waters.

PAST WORK

A brief chronology of previous efforts to review the Nation's range resource and project future demands and uses is in order.

While considerable information about the range has been assembled, no "national," systematic appraisal had been made prior to 1970. Nor had range supply and demand been associated in an analytical framework that would meet Forest Service requirements for range resource planning.

The first survey of consequence was "The Western Range," (USDA Forest Service, 1936) submitted to the Congress in 1936. This survey provided a resume of western range use, its condition, proposals for future administration of the public range, and proposals concerning the Federal Government's role in private range

management. In 1960, a committee from seven professional agricultural societies proposed that a census be made of the Nation's grazing lands as to their size, scope, importance, and use. This proposal was not carried out. Similarly, efforts within the Federal Government to find a universally accepted measure of range productivity were unsuccessful.

In 1961 the Secretaries of the Interior and Agriculture were directed by the Senate Committee on Appropriations to initiate a trial program of appraising range on public land.[1] The subsequent report presented the need for an appraisal that would yield estimates of the total situation on public land range. It also suggested the need for assembling information for the Nation's entire acreage of grazed land —range and pasture. These recommendations were not implemented.

A major undertaking by the U.S. Department of Agriculture under the leadership of the Soil Conservation Service was the National Inventory of Soil and Water Conservation Needs of 1958, updated in 1967. This inventory developed information about the use and the conservation needs of the Nation's private rangelands.

The agencies administering Federal rangelands assembled information in response to requests by the Public Land Law Review Commission. While contributing substantively to knowledge about the Nation's range, the report includes only the Federal lands.[2]

Range research needs have been reviewed, research priorities set, and changes recommended to meet present and future demand. Focus of range research on an ecosystem approach has been recommended. However, planning for range research, and planning for allocation of resources to management of the range both have been hampered by lack of up-to-date resource information on a truly national scope.

THE STUDY REPORT

The Forest-Range Environmental Study met its objectives. In addition, it created a new basis for appraising forest-range. The system developed from the study offers promise of aiding in making multiple-use decisions at the national level. This report describes the study and presents its findings. Detail of selected procedures and information is in companion reports, listed on the inside of the cover page.

The objectives of this report are: (1) To present concepts and methods developed in a new approach to assembly of natural resource information, and its evaluation and analysis, (2) to present the assembled information as a 1970 estimate of the land base and resource output of the Nation's forest-range, and (3) through examination of selected policy alternatives, to illustrate the capabilities of the analytical system to assist in resource allocation. The material is developed in five distinct but related chapters.

The first chapter, "Inventory Concepts and Procedures," reports on the conceptual development of ecosystems, management strategies, yields, costs, and environmental quality indices. All of these relate to the inventory of the land base.

The second chapter, "Resource Situation—1970," describes the land area that is the forest-range environment. Accounted for and discussed under the 34 ecosystems is the 63 percent of the land base in the 48 conterminous States defined as forest-range. Estimates of 1970 levels of range management and production of 22 resource outputs are given.

The third chapter, "Demand for Outputs of the Forest-Range Environment," reports on the conceptual framework of demand analysis and demand projections for the outputs of the forest-range resource. The limitation of the demand (needs) analysis and its use are discussed. Emphasis is on demand for livestock grazing. "Targets" for production of animal unit months of grazing are developed. However, demands for other outputs from forest-range are presented as assembled from existing authoritative sources. The section concludes with an assessment of the needs to year 2000 for outputs from the forest-range.

"Analytical Concepts and Procedures," the fourth chapter, explains procedures used to relate demand and supply of forest-range parameters. The role of efficiency in resource allocation is explained as used in this study. The section then briefly explains the analytical model developed for determining optimum allocation of resources to obtain a particular objective and puts the entire analytical system into focus. The concept of "policy alternative" is explained and the basic types of analyses made are listed. Finally, this section explains the intent and use of constraints in the various alternatives and summarizes the operational assumptions.

The fifth and last chapter, "Analysis of Alternative Mixtures of Resource Use," illustrates the utility of the complete analytical system. It develops selected policy alternatives and discusses predicted shifts in forest-range grazing and management level to obtain the desired animal-unit-month target and under the speci-

[1] Report No. 294 accompanying the Interior Department and related agencies appropriations bill, 1962, and Report No. 394 accompanying the Agricultural and Farm Credit Administration appropriation bill, 1962.

[2] As background to the PLLRC report are manuscripts on 33 subjects. Among those of special interest are: "The Forage Resource" and "Future Demands on the Public Lands."

fied constraints. Expected impacts upon the 22 resource outputs estimated in the study are explored, as well as are costs. Implications of one modified least-cost alternative are explored in some detail.

Concluding the report is an Appendix that contains brief descriptions of the 34 ecosystems developed for use in this study. Some procedures are explained and tables are included that give detail about the forest-range land base and outputs in 1970 and detail to one alternative. Contributors are named.

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Chapter I

INVENTORY CONCEPTS AND PROCEDURES

To study the forest-range resource in a systematic manner, it was first necessary to establish a uniform framework of land inventory, management strategies, and outputs suitable for all sectors and within the bounds of computational procedures. These procedures are explained in this chapter.

Most of the concepts and methods were conceived under direction of the forest-range task force. Special tasks, such as describing ecosystems, defining and developing management strategies, and estimating resource responses, were carried out by teams of USDA Forest Service experts. Models and computer programs were developed by the Forest Service and the Economic Research Service of the USDA, and the University of Nebraska Computing Center, Lincoln, Nebraska.

LAND INVENTORY

The term "forest-range" covers all land in the 48 conterminous States that is in native and natural grasslands and commercial and noncommercial forest lands, if at some stage of their natural succession, or if under management, they produce vegetation that is grazeable by livestock. Desert areas such as salt flats and playas, and barren areas above treeline also were included. Excluded were urban lands, transportation system lands, improved pasture, croplands, and major waterways.

Areas called "resource units" were formed to establish ecological units that would be relatively homogeneous at the national level. The intent was to provide a set of land units for which present productivity of range outputs could be estimated, and for which future outputs under varying levels of management could be predicted. To accomplish this, each resource unit was classified according to 34 ecosystems, 3 ownerships, 4 productivity classes, and 3 condition classes. A resource unit as used in this report is, thus, an area of land within one of the 34 ecosystems, under one of 3 ownerships, and in one of 4 productivity classes and 3 condition classes.

The ecosystem classification was adapted from the work of A. W. Küchler (1964). He classified the United States into 106 major plant communities (phytocenoses) based on the natural vegetation that would exist if man were removed from the scene and the resulting plant succession telescoped into a single moment. Although many of his major plant communities are presently managed so that they will not evolve, his concept provided a basic common denominator to reflect the biological potential.

To simplify data compilations, two major modifications were made of Küchler's classification to form the 34 ecosystems: [3]

(1) Closely related Küchler types were combined into single ecosystems.

[3] A brief description of each ecosystem and correlation of the ecosystems with Küchler's classes is presented in Appendix A.

(2) USDA Forest Service's forest survey types that are related to potential natural vegetation were used to define forest ecosystems (U.S. Forest Service 1967).

The modified list, grouping ecosystems into ecosystem groups, referred to in this report as ecogroups, follows:

Western Forest
- Douglas-fir
- Ponderosa pine
- Western white pine
- Fir-spruce
- Hemlock-Sitka spruce
- Larch
- Lodgepole Pine
- Redwood
- Hardwoods

Western Range
- Sagebrush
- Desert shrub
- Southwestern shrubsteppe
- Chaparral-mountain shrub
- Pinyon-juniper
- Mountain grasslands
- Mountain meadows
- Desert grasslands
- Annual grasslands
- Alpine

Great Plains
- Shinnery
- Texas savanna
- Plains grasslands
- Prairie

Eastern Forest
- White-red-jack pine
- Spruce-fir
- Longleaf-slash pine
- Loblolly-shortleaf pine
- Oak-pine
- Oak-hickory
- Oak-gum-cypress
- Elm-ash-cottonwood
- Maple-beech-birch
- Aspen-birch
- Wet grasslands

The forest survey types were used because no other classification scheme existed for the forest that had an associated land base. However, many of the forest survey types are in several different stages of forest successional development, causing them not to mesh, in all cases, with Küchler's plant communities. Thus, some Küchler types appear in more than one FRES ecosystem.

Within each ecosystem delineation, the land areas were further subdivided so that data could be analyzed on a production and condition basis. For the range ecosystems, productivity classes were expressed in terms of traditional concepts of herbage production. Condition classes were based on vegetation cover, composition, and vigor, as well as soil factors (table 1). For the forest ecosystems, productivity and condition classes were expressed in terms of volume of wood produced and timber stand-size class. The three ownership classes specified were: (1) National Forest System, (2) other Federal, and (3) non-Federal. Complete expansion of the land classification system yields 1,224 resource units. However, all possible combinations did not exist. Data were collected and evaluated for the 956 resource units for which they were available.

All the land base data used in the inventory was taken from existing inventories. The acreages were compiled by resource unit, ownership, State, and one of four geographic regions (fig.

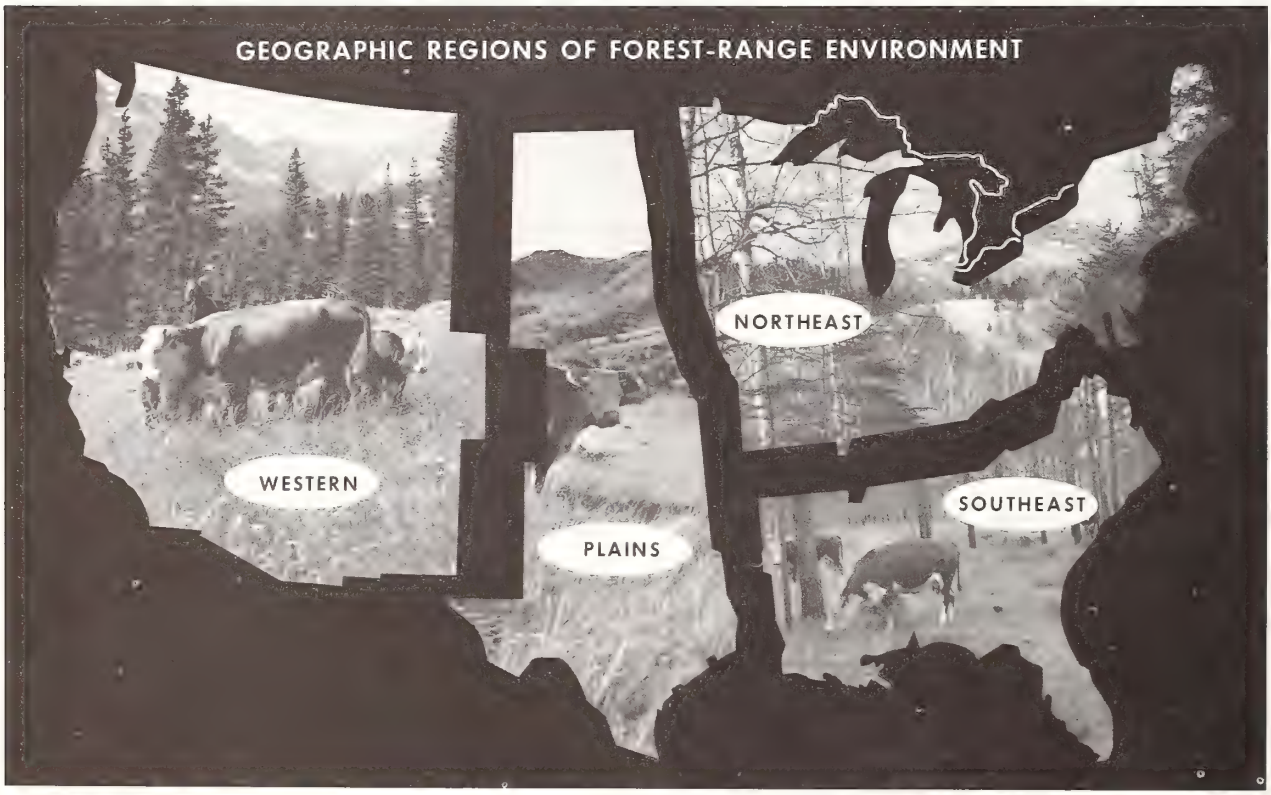

FIGURE 1.

1). Thus, the land inventory provided important dual properties: analysis could be accomplished on an ecological basis; and it could be transformed to meaningful geographic units for evaluation and presentation.

TABLE 1.—*Productivity and condition classes*

Forest ecosystems	Range ecosystems
Productivity	
Wood	Herbage
cubic feet per acre per year	
120 +	First quartile
85 to 119	Second quartile
50 to 84	Third quartile
0 to 49[1]	Fourth quartile
Condition	
Timber	Range
Nonstocked	Good
Seedling, sapling, and pole[2]	Fair
Sawtimber[3]	Poor

[1] Commercial forest types that produce less than 20 cubic feet are classified by the USDA Forest Service as noncommercial. Forest lands in this category were placed in the low productivity class.

[2] Stands with seedlings and saplings or poles having trees up to about 9 inches in diameter.

[3] Stands with sawlogs having at least 50 percent of the trees above 9 inches in diameter; in the Far West, 11 inches.

The actual compilation procedures differed for the forested and nonforested ecosystems (fig. 2 and fig. 3). For the forested ecosystems, acreages were derived from preliminary forest survey data for 1970 Timber Review, USDA Forest Service, and rearranged to fit the resource unit classification scheme. As an example, acreages of the three timber stand-size classes for poles, saplings, and seedlings had to be aggregated to form one "condition" class. Also, within the publicly owned lands in the Forest Survey data were State, county, and municipal lands which had to be transferred to the non-Federal category.

F—389158

FIGURE 2.—The Oak-hickory ecosystem on Mark Twain National Forest, Missouri.

F—440852

FIGURE 3.—The Desert shrub ecosystem in Utah.

The acreage information for the nonforested ecosystems was taken from inventories kept by the various Federal agencies. Land data for the nonforested lands in the National Forest System were taken from an inventory made in 1967 by the USDA Forest Service to provide information for the Public Land Law Review Commission (University of Idaho 1969). Data submitted by field units included classification of about 18 million acres within 2,200 range allotments by eleven standard vegetation types, seven grazing capacity classes, and four range condition classes. The sample was expanded and the vegetation types cross-referenced to ecosystems. Following is the procedure used to accomplish this:

1. Küchler types were matched with the broad vegetation types used in existing range inventories.

2. Where two or more Küchler types fell in the same range inventory type, but were included in different FRES ecosystems, proportionate percentages were developed as follows: An acetate transparency with State and National Forest boundaries was laid over Küchler's map and proportions were determined for National Forest System lands in each State. A set of percentages was thus developed for each State. The sample data were then expanded to the total population.

3. Since the inventories of the "range" and "forest" ecosystems were developed from different sources, neither of which represented the total area of the National Forest System, the sum of the two did not necessarily add up to

the total area in the National Forest System. Because the 1970 Timber Review was the most up-to-date of the two, the adjustment to bring the acreage to the official total area of the National Forest System was made in the nonforested ecosystems.

Acreage data for other Federal lands were taken from a wide variety of published and nonpublished reports provided by various Federal agencies. These sources were:

1. 1963 and 1964 Summaries of range condition reports, Bur. Land Mgmt., U.S. Dept. Int.
2. Grazing capacity classes by vegetative types (1970 data), Bur. Land. Mgmt., U.S. Dept. Int.
3. Public Land Statistics—1949, Bur. Land Mgmt., U.S. Dept. Int.
4. Definitions of vegetation classification (Form 10–430), Natl. Park Serv., U.S. Dept. Int.
5. Fire protection acreage summary. Acres by State, by vegetation types, April 1970. Natl. Park Serv., U.S. Dept. Int.
6. Statistics for forage study provided Public Land Law Review Commission by the Natl. Park Serv., Dec. 1967.
7. Martin, R. O. R. and Hanson, R. L. Reservoirs in the United States. Geological Survey Water-Supply Paper 1838. 1966.
8. Land use inventory and production record report 50–1: Part I—Ownership and land use class of lands under Bur. Indian Affairs jurisdiction; Part VI—Status of conservation program, calendar year 1969. Bur. Indian Affairs, U.S. Dept. Int.
9. Acreage of range condition classes, Bur. Indian Affairs, U.S. Dept. Int., May 1, 1970.
10. National wildlife refuges: Summary of farming, grazing, haying, and timber programs, calendar year 1969, Bur. of Sport Fisheries and Wildlife, U.S. Dept. Int.
11. Report of classification of refuge lands, 1965, Bur. of Sport Fisheries and Wildlife, U.S. Dept. Int.
12. 1968 List of National wildlife refuges, Bur. of Sport Fisheries and Wildlife, U.S. Dept. Int.
13. Annual report of lands under control of the Bureau of Sport Fisheries and Wildlife, 1969, Bur. of Sport Fisheries and Wildlife, U.S. Dept. Int.

Data from these reports were cross-referenced to the ecosystem using the same basic procedure as for the National Forest System lands.

However, determination of the rangelands for the non-Federal lands presented a more difficult problem. The Conservation Needs Inventory (CNI), which was the main source of information, does not contain tabulations of acreages by vegetation types, grazing capacity classes, and condition classes per se (U.S. Department of Agriculture 1971). Rangeland and pasture acreages are tabulated by treatment needs. Using the definitions in the CNI handbook, the data were extrapolated into broad vegetation types, and grazing capacity and condition classes. The data were then fitted into the ecosystems in the same manner as for the Federal lands. To account for all acres of forest-range, salt flats and playas were included within Desert shrub and Desert grasslands ecosystems to which they were proximate. Barren areas above treeline were included in the Alpine ecosystem.

MANAGEMENT STRATEGIES

To establish the link between range activities and the resource and to solve the problem of massive numbers of possible management options, six management strategies were defined (fig. 4). Except for exploitative grazing (strategy X), each of these strategies can be viewed as a management objective. In strategies B through D multiple-use is considered as a constraint on the degree that grazing could be emphasized, while Strategy E was subject only to the stewardship of land and water resources.

The five strategies with management objectives were:

A. Environmental management without livestock. Livestock are excluded by fencing, riding, public education, and by incentive payments. The environment is protected from natural or other disasters, such as wildfires or pest epidemics. Resource damage is corrected to maintain a stewardship base. Costs for this strategy are charged to other benefiting resource areas (watershed management and timber management) and to stewardship resource areas (fire protection, pest control, and lands). That is, no cost is charged to range under this strategy.

B. Environmental management with livestock. Livestock use is within the apparent present capacity of the range environment. Investments for range management are applied only to the extent required to maintain the environment at a stewardship level in the presence of grazing. Investments for implementation may be very low for some resource classes. Resource damage resulting from past use is charged to benefiting or stewardship functions. The goal for the strategy is to attain livestock control. No attempt is made to achieve livestock distribution.

C. Extensive management of environment and livestock. Management systems and techniques, including fencing and water developments, are applied as needed to obtain relatively uniform livestock distribution and plant use, and to maintain plant vigor. Management seeks full utilization of the animal unit months available for livestock grazing. No attempt is made to maximize livestock forage production by cultural practices such as seeding.

D. Intensive management of environment and livestock. All available technology for range and livestock management is considered. Management seeks to maximize livestock forage production consistent with constraints of maintaining the environment and providing for multiple use. Existing vegetation may be replaced through improvement in growing conditions. Structures may be installed to accommodate complex livestock management systems and practices. Advanced livestock management practices are commonplace.

E. Environmental management with livestock production maximized. Stewardship of soil and water are required. Timber may be completely removed. Multiple use is not a constraint.

Management at an exploitative level (Strategy X), the sixth strategy, was included in order to inventory the existing activities, to estimate the extent of exploitative management, and to evaluate the consequences of applying this type of treatment to the resource. Exploitative grazing use was defined as grazing in a manner that depletes the soil or vegetation and violates the principle of sustained yield. Attainment of this strategy was not a management goal.

Using the basic definitions of the management strategies, packages of range management practices were assembled for each of the 956 resource units which when applied should result in attainment of the management goal for the strategy level.

Four types of information were assembled for each resource unit. This was needed in order to develop a data base along with acreage limitation caused by physical and biological factors and legal limitations. The four types of information were:

1. Now situation—the proportion of land that was being managed under each strategy as of 1970.
2. Now policy—commitments or plans as of 1970 to change the strategy mix on each resource unit by the year 2000.
3. Maximum limit—the maximum proportion of a given resource unit to which a given management strategy can be applied when considering only physical and biological constraints.
4. Minimum limit—the least amount of land that can be managed in a given strategy because of laws, institutions, or policy commitments.

Collection of data for each strategy involved two teams made up of personnel from each National Forest System Region, Research Experiment Station, and State and Private Forestry Area of the Forest Service, U.S. Department of Agriculture. One team of 30 members handled most of the Great Plains and West ecosystems; the other, comprised of 20 members, handled the Northeast and Southeast. Team members represented a broad range of scientific disciplines including range science, forestry, ecology, hydrology, soils, watershed, landscape architecture, recreation, resource economics, and wildlife management.

Leaders of each team established working groups, based on knowledge about specific ecosystems, their management, physical and biological features, and level of development. Each team developed values for one ecosystem and discussed the general concepts that were used. Time priorities were established for each ecosystem based on potential range values. For instance, in the Western Forest ecosystems, the highest priority was placed on Ponderosa Pine and the lowest was assigned to Redwood.

Each working group was structured differently. In the West, for example, the forest ecosystem group worked as a unit while the range ecosystem group was subdivided based on special knowledge of team members. But the structure of these groups was flexible and was changed while values were being developed in order to make best use of each member's experience or area of skill. Thus, team members worked on problem areas where they were competent and could provide expertise.

As the study progressed, an effort was made to coordinate development of the ecosystem values. After the values were developed for each ecosystem, results were organized and presented for review by the entire team. This provided an opportunity to adjust the values using the experience of all members. Group leaders met frequently to evaluate general concepts and to insure uniformity between working groups.

In developing the actual management strategies, the work groups selected a set of range management practices needed to implement the five strategies in each resource unit. To accomplish this the group members first identified typical management areas used in the resource units and their geographic location. Management areas varied in size from 5 acres in Mountain meadows to 10,000 acres in Desert shrub. These areas provided bench marks from which to work.

FIGURE 4.—Six management strategies to achieve range resource objectives.

Strategy A – Environmental management without livestock.

Strategy D – Intensive management of environment and livestock.

Strategy B - Environmental management with livestock.

Strategy C - Extensive management of environment and livestock.

Strategy E - Environmental management with livestock production maximized.

Strategy X - Management at an exploitative level.

Then from a list of 18 range practices listed below, strategies were developed based on current management recommendations from the bench mark areas. As an example, for strategy B, control of livestock by fencing and simple development of stock water was usually stressed (fig. 5). Group members in many instances used published or their personal re-

FIGURE 5.—Fencing and stock water developments are common range practices.

search or management experience to identify what practices should be applied. In addition, team leaders provided available backup information and research findings from outside sources. In the Sagebrush ecosystem, for example, information was provided from the cooperatively developed Vale Project in Oregon. The Vale Project is a large range rehabilitation project on Federal range administered by the Bureau of Land Management where sagebrush was replaced with crested wheatgrass.

Range practices used to develop management strategies:

1. Fertilization.—The application of nutrients to the soil that will improve production of herbage. The per acre cost of fertilization for each ecosystem was based on the pounds of nutrients applied to the soil.

2. Irrigation. This practice was designed to supply water to areas that were deficient in moisture. Examples of irrigation systems used in the practice were sprinklers, ditches, and waterspreading,

3. Drainage. This practice centers around draining or lowering the water level on marshes, bogs, or other areas that sustain standing surface water for long periods of time. Lands in these categories generally can be treated mechanically to remove the water, thus allowing use by livestock and wildlife.

4. Brush control-mechanical. This practice includes all brush control work accomplished by a mechanical means. It includes such treatments as plowing, chaining, pushing, disking, root plowing, crushing, and cutting. Brush control varies by ecosystem and includes such species as sagebrush, rabbitbrush, mesquite, pinyon, juniper, chaparral, and oakbrush. Follow-up seeding, when required, was included in practice Number 11, Seeding. Brush control on timber types is the control of brush after clear-cutting and the control of understory brush in timber stands.

5. Brush control-chemical. This practice includes those areas where herbicides are used as a primary agent for control of brush species. Application can be by air or surface techniques and in the form of liquids or solids.

6. Brush control-biological. Biological control pertains to the use of insect, fungi, virus, or other biological measures in the control of brush species.

7. Brush control-fire. Fire is used as a means of controlling brush. It may also be used to improve the availability of browse. When seeding was required in the follow-up sequence, it was included in practice Number 11, Seeding.

8. Debris disposal. This is the disposal of material following some other treatment to improve esthetics, increase forage yield, or to reduce fire hazard. It includes burning, crushing, beating, and chaining.

9. Undesirable forb control. This is the aplication of methods aimed at eradication or control of undesirable herbaceous range plants. It includes noxious farm weeds, poisonous plants, and other species such as fiddleneck, knotweed, false-hellebore, tarweed, and wyethia. Control is by chemical, biological, fire, or mechanical means.

10. Mechanical soil treatments. This is the physical disturbance of the soil through practices such as chiseling, pitting, contour furrowing, or other mechanical means. These practices were designed to accomplish a variety of objectives such as preparing a seed bed, increasing water infiltration, controlling erosion, and improving microclimate.

11. Seeding. This practice included all seeding. Where seeding was done in conjunction with plant control or other practice, it was included under this item. Seeding methods include drilling, broadcasting, and/or other techniques.

12. Prescribed burn for forage improvement. This includes burning for the purpose of removing rough herbaceous residue, improving nutrient content, and increasing production.

13. Rodent control. This is the reduction of rodent populations that are detrimental to the range resource. Control programs are carried out primarily in conjunction with range seeding projects or in areas where rodent population density is great enough to cause range deterioration.

14. Insect and disease control. This is the reduction of insect populations and diseases that affect the range resources adversely. Grasshoppers, grassbugs, and rusts are examples. All treatment methods are included in this category.

15. Small water developments. Included in this practice are earth dam and pits, small spring developments, shallow wells, and wildlife "guzzlers" which would make a single stockwatering site. A battery of troughs for watering sheep is counted as one stockwatering site.

16. Large water developments. Included in this practice are wells, trick tanks, spring developments, seeps, and ditches generally involving water storage and distribution systems. For example, a single water source with three watering sites dispersed along four miles of pipeline would be counted as three watering sites.

17. Fences. This practice includes all types of range fences such as let-down or log type fences in the heavier snow areas and barbed wire, steel post type fences in the plains.

18. Timber thinning. This is the removal of suppressed, deformed, or otherwise poor quality trees from a commercial timber stand to provide space for the remaining trees. Only that

portion of thinning that exceeds the requirements for tree production and is performed to increase forage production is considered a range practice.

The work groups first developed strategies by productivity classes and then made adjustments by condition classes. Strategies were converted to 100-thousand acre units. Numbers of units of practices needed to attain the goal of the strategy on the individual resource unit were recorded (fig. 6). In developing the strategies, the major problem was the use of fertilizers. Team members' experience with fertilizers was limited to small plot research.

COSTS

Costs for each strategy were computed based on the constant amount, including 6 percent interest, that would have to be paid each year, even though the amount of capital invested may vary from year to year. Costs were annualized because some strategies required a higher proportion of short-lived practices than others, and interest was added to reflect the social cost of selecting those practices that tie up capital.

For each strategy the annual investment and maintenance costs for selected practices were calculated. Management and supervision expenditures were then added.

The cost of practices for each resource unit was determined from published sources and from experience of selected experts in this field.[4] Publications used included Agricultural Stabilization and Conservation Service cost and practice handbooks and USDA research publications on the subject. A cost for doing each practice was determined if the practice could be performed biologically on a resource unit. Since the values were averages, some costs reported were obviously higher or lower than average. In developing these values, however, land ownership was found to have no influence on the unit cost or life expectancy of a practice, when the practice was done to the same standard and all elements included. For example, costs on some privately owned land appeared

[4] See Appendix B for the cost rationale for each practice and basic cost data. Also see "Range Management Practices: Investment Costs, 1970." (Reference inside cover page.)

Form No. 2C, Rev. 9-30-70
Forest Range Environmental Study - 1970

Sequential Code Number_____

MANAGEMENT PRACTICES

Filled In By Washington Office

CODE 2 (1) 9 (2) 1 (3) 3 (4) 3 (5) 5 (6)

7	8	9	10	11	12
			1	0	0

M ACRES

Ecosystem (1, 2) Sagebrush Ownership (3) National Forest Prod. Class (4) 3 Cond. Class (5) 3

Mgt. Strat. (6) E

	Practice	Col.	Units: Number	Units: Kind	ID Code Col. 80
CARD R	1 Fertilization	14-19	1	M Acres	
	2 Irrigation	20-25		M Acres	
	3 Drainage	26-31		M Acres	
	4 Brush control-Mech.	32-37	55	M Acres	
	5 Brush control-Chem.	38-43		M Acres	
	6 Brush control-Biol.	44-49		M Acres	
	7 Brush control-Fire	50-55	5	M Acres	
	8 Debris disposal	56-61		M Acres	
	9 Undesirable forb. Cont.	62-67	1	M Acres	
	10 Mech. soil treatment	68-73	10	M Acres	R
CARD S	11 Seeding	14-19	70	M Acres	
	12 Prescribed burning	20-25		M Acres	
	13 Rodent control	26-31	6	M Acres	
	14 Insect & dis. control	32-37		M Acres	
	15 Small water development	38-43	60	Sites	
	16 Large water development	44-49	90	Sites	
	17 Fence	50-55	80	Miles	
	18 Timber thinning	56-61		M Acres	S

Date Completed: 10/28/70

Sub-Team Leader: Ed Smith

FIGURE 6.—Form used to record management practices.

to be lower than those on Federal land; but closer examination showed that some element of the practice had been left out such as labor, equipment, costs, and interest.

RESOURCE OUTPUTS

Response of each of the 956 resource units to the level of management represented by each management strategy was predicted for each of 22 resource outputs. This was done by the teams that also developed the management strategies. Although the strategies were not designed principally to achieve outputs other than livestock grazing, some have significant impact upon the yield of other goods and services. Nine of the 22 outputs were quantitatively measured. The remaining 13 were expressed using a qualitative rating system.

The qualitative values, numbers 10 to 22, are the most unique. The purpose of these estimates was to summarize in a score the resource unit's response to the impact of the strategies for which quantitative measures were not readily available. Perhaps the spirit of measurement of these products can best be summed up by a statement by S. S. Stevens (1958):

> Measurement . . . is more than the pedantic pursuit of a decimal place. Its vital and absorbing aspect emerges most clearly when it becomes a question of measuring something that has never been measured. Or, better still, something that has been held to be unmeasurable.

A numerical 5-point scale was used to measure outputs number 10 to 22. The 5 points were:

Excellent	5	Poor	2
Good	4	Bad	1
Fair	3		

The 22 resource outputs, listed below, varied greatly in form, value, and measurement technique. For example, each of the grazing measures had different properties. Animal unit months (AUM's) was the estimated rate to which a particular strategy and resource unit could be stocked with livestock. Herbage yields were associated with the habitat created for both livestock and game animals. Animal output value was an extension of animal unit months to reflect quality considerations associated with different levels of livestock management. Thus, while all three grazing measures were interdependent, each had its own quality.

Numbers 1, 2, and 3 are grazing measures; numbers 4 to 9 are joint outputs; and numbers 10 to 22 are qualitative estimates.

The list of resource outputs follows:

1. Animal unit months—stocking rate of livestock intended for each management strategy to the nearest 0.01 AUM.

2. Herbage and browse—current year's production of leafy or twig material in tons-per-acre to the nearest 0.1 ton.

3. Animal output value—dollar value per acre of livestock production to the nearest 0.1 dollar. This value was obtained by multiplying AUM per acre by the following factors for each strategy: \$6.50 for Strategy B, \$8.00 for Strategy C, \$9.00 for Strategies D and E, and \$15.00 for Strategy X. Animal output value reflects the expected gains in animal productivity and quality resulting from more intensive management. It was recognized that this value could vary depending upon the type of operation (cow-calf, cow-yearling, buy-sell, etc.). But in order to reflect inherent differences in the land base rather than entrepreneur options, the gross value per animal unit month for a typical cow-calf operation was used as the norm.

4. Employment — primary permanent employment generated by full use of the range-associated outputs of the management strategy expressed in man-hours per acre, per year, to the nearest 0.01 man-hour. It was assumed that existing allotment structure and ranching enterprises remain intact, and that the implementation of management strategies would increase or decrease the employment level to that specified for this strategy outcome. It was estimated that livestock production in the Eastern ecosystems required an average of 0.6 man-hours per animal unit month and for the Western ecosystems 0.9 man-hours per AUM.

5. Wood—net growth of merchantable wood in cubic feet per acre per year.

6. Water yield—yield of water in acre-feet per acre per year to the nearest 0.1 acre-feet for the yield expected under a management strategy.

7. Quality water—yield of water in acre-feet per acre per year to the nearest 0.1 acre feet which meets prescribed standards.

8. Storm runoff—the amount of runoff expected for a 2-year 2-day storm for a given site expressed in 0.1 inches per acre.

9. Sediment — the sediment deposited in stream channels in tons to the nearest 0.1 of a ton per acre per year.

10. Soil stability—changes expected in surface soil movement.

11. Soil quality—changes expected in fertility, structure, or drainage of the soil. Fertilization or drainage might be expected to rate excellent (5).

12. Air quality—carbon and particulate content of the atmosphere. For example, conver-

sion of Douglas-fir forest to grassland may rate (2), because the decrease in carbon stored in decay-resistant organisms will result in a higher atmospheric carbon dioxide (CO_2) content. Seeding and related improvement of depleted grasslands may rate fair (3) or good (4) because dust content of the atmosphere may be decreased.

13. Environmental beauty—esthetic impact of a strategy upon the landscape. Beauty was evaluated with respect to scenic appeal or to the quality of spiritual appeal to solitude.

14. Rare and endangered species—changes in population for those species which are permanent, summer, or winter residents in the resource unit. For example, a strategy which included prescribed burning in the white-red-jack pine ecosystem may be rated excellent (5) because it tends to create the nesting habitat for the endangered Kirtland warbler. Conversely, a strategy which includes conversion of this ecosystem to grassland may be rated bad (1) because it would decimate the nesting habitat of the species.[5]

15. Non-game birds—diversity of habitat for those species which are permanent, summer, or winter residents in this resource unit. For example, a strategy which reduced the number of vegetation strata or tended to concentrate the foliage in a single stratum would reduce the diversity of bird species. Thus, converting a climax stand of deciduous forest to grassland would have a bad (1) effect. Introduction of shrubs into Plains grasslands may have a good (4) effect.

16. Carnivores and raptors—animal numbers for those species which are permanent, summer, or winter residents of the resource unit. For example, strategies that include control of prey species may have a poor (2) effect; strategies that perpetuate extensive management of "wilderness" conditions may have a good (4) or excellent (5) effect.

17. Hunting—impact upon the number of healthy game animals. For example, in the Sagebrush ecosystem, a strategy that includes mechanical control of sagebrush may have a poor (2) or bad (1) effect upon hunting. Thinning in the Douglas-fir ecosystem may have a good (4) effect.

18. Other outdoor recreation—an estimate based upon visitor days per acre.

19. Depressed area impact—economic impact of a strategy upon the residents of an Economically Depressed Area.[6]

Qualitative factors from 1 through 5 were assigned for this output. These factors are: 1-bad, 2-poor, 3-fair, 4-good, and 5-excellent. Their relationships are shown in the following tabulation:

Management strategy	*Percent of ecosystem within economically depressed areas*				
	0–20	25–40	45–60	65–80	80–100
No livestock (A) ____	1	1	1	1	1
Some livestock (B) __	1	1	1	1	1
Extensive mngt. (C) _	1	1	1	2	2
Intensive mngt. (D) _	1	1	2	2	3
Maximize livestock (E)	1	2	3	4	5
Exploitative mngt. (X)	1	1	1	1	1

20. Cultural heritage, resident—impact of a treatment upon an established local tradition, image of life, morés, institution or environmental characteristic when viewed as affecting residents of the local environment. Examples: pinyon nut gathering, cattle round-up, trail herding of sheep or cattle. Complete elimination of pinyon-juniper cover would wipe out nut gathering which is important to Indian tribes of the Southwest. This would rate (1) whereas strategy A would encourage pinyon cover and the associated nut gathering would be expected to be good to excellent, and would rate a (4) or (5).

21. Cultural heritage, non-resident—impact upon an established tradition, image of life, morés, institution or environmental characteristic when viewed as affecting a nonresident of the environment under consideration. For example, consider the Marlboro syndrome (cowboying on the range), a heritage which the non-resident looks forward to seeing on the western range. A management strategy such as no livestock (A) which eliminates this would rate bad (1); a strategy such as intensive management (D) or especially maximizing livestock production (E) may rate poor (2) or fair (3); a strategy more in tune with the Marlboro picture such as some livestock (B) or extensive management (C) may rate good (4) or excellent (5).

22. Flexibility for future management—ease with which management direction can be altered. Basically, multiple-use management provides for a high degree of flexibility for future management. Single-use management, on the other hand, usually results in just the opposite.

Yields for each of the 22 resource outputs were evaluated with regard to the response expected after the mix of practices had taken full effect and the influence had stabilized. Hence, the yields represent the culmination of output response from the application of the strategies rather than representing average yields. Such an approach was adopted since the results of the study were intended for long-term policy analysis. Underlying this is the

[5] See Appendix A for list by ecosystem.

[6] See Appendix A for percent area economically depressed by ecosystem.

assumption that the small variation involved in time of culmination, together with the long-range policy horizon, would not significantly change the results studied.

Resource responses were estimated from the best available information. Grazing values had the most backup information in terms of team members' experience and research information. Output values from wood were derived from research information developed over the years and from periodic inventories by the U.S. Forest Service. Hydrologic outputs were difficult to determine. These values should be considered indexes rather than absolute values. These data are, however, relevant to available statistics. Published information on past and present outputs in the form of generalized maps and reports were used to provide the base data. In addition, reports of field investigations including River Basin studies were used for extrapolating data from broad areas such as Water Resources Council Regions to the resource units.

Grazing production values were generally determined first. For some ecosystems, bench marks were established from long-term animal-unit-month production data. But for others, little or no data were available. Here production estimates were calculated from herbage yields reported in research publications and adjusted based on management experience of the working groups. The other quantitative values were then estimated. If no expert for these values was represented in the working group, other experts were called upon. Once the quantitative estimates were developed for an ecosystem, the values were reviewed by the total team.

The qualitative values for the ecosystems, which are actually indexes expressing the effects of the management strategies, were determined with the assistance of team members who were experts for the qualitative factors: a wildlife biologist assisted in determining the qualitative values pertaining to habitat for rare species, non-game birds, carnivores and raptors, and hunting; a hydrologist assisted where water was involved, and soil scientists did the same for soil. Considerable discussion by team members usually accompanied the development of the value. This made it possible to ascertain and review the reasoning process used in developing the values. If different viewpoints were encountered, consideration was given to all views and a consensus arrived at for the various outputs. These values were then recorded (fig. 7) and the data processed for analysis.

The data were ready for analysis upon the development and definition of the resource units, the cost structure and the recording of acreages for the management practices for the various management strategies. The first order of discussion after developing the measurement procedures and recording the data was the development of the data base. This was done before determining demands and alternative mixtures of management strategies for resource uses. The resource situation as of 1970 was used as the data base. This assumption was necessary in order to provide an inventory of the existing forest-range resource.

SUMMARY

The Forest-Range Task Force wanted to place the traditional emphasis on range for livestock use, but also wanted to explore the interrelationships among livestock use and range as a source of multiple goods and services. Investigation of this type required an analysis of the relationship of management and treatment options to the quantity, quality, and mix of outputs within, as well as between, various types of land resources. It was recognized that measurement of the "total" system was far beyond the scope of known techniques. An almost infinite array of resource-output combinations and management options existed. Consequently, to study the forest-range system, it was necessary to establish a uniform framework of land inventory, management, strategy, and output responses suitable for all sectors and within the bounds of computational procedures.

The system developed permitted the use of the existing land base and resource output information. The first step was to establish land areas called resource units. Each resource unit was classified according to 34 ecosystems, 4 productivity classes, 3 condition classes, and 3 types of ownership. Next, to link range management activities and outputs with land base, five management strategies of increasing management intensity for grazing were designed for each resource unit. Each of these consisted of a mix of conventional range management practices that would attain the desired management level when fully implemented. A sixth strategy—exploitative management, was recognized.

Although the strategies were designed principally to achieve targets for outputs of livestock grazing, they do have an impact upon the yields of other goods and services. In order to evaluate these impacts, yields of 22 outputs associated with each management strategy were included in the inventory. Animal unit months of grazing was the primary output. The other values were considered as joint outputs obtained from range management options; they varied greatly in form, value, and mea-

Form No. 3A (Rev. Sept. 30, 1970)
Forest-Range Environmental Study - 1970

Sequential Code Number_____

RESOURCE OUTPUT ESTIMATES AND COSTS BY MANAGEMENT STRATEGY FOR A RESOURCE UNIT

Filled In By Washington Office

CODE 2 9 3 3 1 (1 2 3 4 5)

M ACRES 1 0 0 (8 9 10 11 12 13)

Ecosystem (1, 2) Sagebrush Productivity Class (3) 3 Condition Class (4) 3 Ownership (5) National Forest

MANAGEMENT STRATEGIES		DO NOT USE	PRODUCTS 1 Herbage & browse-tons/acre	2 AUM's/acre	3 Animal output Value - $/acre	4 Wood 100 cu. ft./acre	5 Water yield ac. ft./acre	6 Quality water ac. ft./acre	7 Storm runoff inches/acre	8 Sediment tons/acre	9 Employment man hours/acre	10 Soil stability	11 Rare species	12 Non-game birds	13 Carn. & raptors	14 Air quality	15 Soil quality	16 Depr. an. impact	17 Cult. Her. Res.	18 " Non-res.	19 Beauty	20 Hunting	21 Oth. recreation	22 Mgt. flexibility		Edit code Card ID
Exploitative	X		0.3	0.06	.3	0.0	0.3	0.3	0.3	150	0.05	1	1	1	2	1	1	2	2	2	2	2	1		Y
No grazing	A		0.3	0.0	0.0	0.0	0.2	0.2	0.1	8.3	0.01	1	3	3	4	3	1	1	3	3	3	3	3		Y
Some livestock	B		0.3	0.01	0.1	0.0	0.2	0.2	0.1	8.3	0.01	1	3	3	1	3	2	1	4	4	4	3	3		Y
Extensive mgt.	C		0.3	0.03	0.2	0.0	0.2	0.2	0.1	8.3	0.03	1	4	4	4	3	2	1	3	3	3	3	3		Y
Intensive mgt.	D		0.3	0.2	1.8	0.0	0.1	0.1	0.1	8.3	0.18	2	4	4	3	4	2	1	2	2	3	3	3		Y
Maximum mgt.	E		0.4	0.3	1.8	0.0	0.0	0.0	0.0	1.6	0.27	2	2	2	2	5	2	3	2	2	2	1	2		Y

(14 26 29 33 37 40 43 46 49 52 54 56 57 58 59 60 61 62 63 64 65 66 67 68 69 79 80)

Date Completed: 11/12/70

Sub-Team Leader: Ed Smith

FIGURE 7.—Form used to record resource responses.

surement technique. About half were quantified in familiar terms, while the rest were evaluated by a qualitative rating system from 1 (bad) to 5 (excellent).

All the land base data were taken from existing inventories kept by the various Federal agencies. Collection of data, both for the strategies and output responses, involved personnel from three Forest Service program arms—the National Forest System, State and Private Forestry, and Research—and many disciplines. Values for each product were estimated, based on the culmination of and response to management strategies. This assumes that the variation in time lags among resource units, together with the long-range policy horizon, will have no significant effect on model solutions.

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Chapter II

RESOURCE SITUATION—1970

This chapter describes the Nation's land area that is in the forest-range environment. In addition, using procedures described in Chapter I, estimates are presented of 1970 livestock management activities on these lands and their impact on 22 output values.[7] The data presented provide the basis for evaluating the various management alternatives described in Chapter V, Analysis of Alternative Mixtures of Resource Use.

LAND BASE—1970

Forest-range environment, lands in native and natural grasslands, and commercial and noncommercial forest that can produce vegetation grazable by livestock, comprise 1,202 million acres. This represents 63 percent of the total land area in the 48 conterminous States.

Every State has a significant amount of forest-range (fig. 8). In 35 States more than one-half of all the land is forest-range; the proportions approach or exceed 90 percent in such widely dispersed States as Maine, New Hampshire, Nevada, New Mexico, and Wyoming. Even some States with high populations have a sizable proportion of forest-range lands. New Jersey, for example, with an area of 4.8 million acres, has an estimated 2.2 million acres, or 47 percent, in forest-range. Similarly, the traditionally important crop-yielding Midwest Corn Belt States have sizable acreage. Illinois, Indiana, Iowa, and Ohio combined have about 16.6 million acres that are classified as forest-range.

The 11 Western States dominate, however, both in terms of total area and proportion of land in forest-range. The Western States contain 622 million acres of forest-range, 83 per cent of the area (table 2). For the other regions, the Great Plains has 214 million acres or 53 percent, Southeast 184 million, or 61 percent, and Northeast 182 million, or 41 percent. For the Nation, 52 percent of the forest-range lands are in the West, 18 percent are in the Plains, and the Southeast and Northeast regions contain 15 percent each.

TABLE 2.—*Forest-range, improved private pasture, and other land by geographic region, 1970*

(Million acres)

[Totals may not add due to rounding]

Geographic region	Forest-range environment	Improved private pasture	Other land	Total land area
Western	621.7	8.9	122.4	752.9
Plains	213.9	24.0	169.3	407.2
Northeast	182.0	39.9	219.4	441.2
Southeast	184.1	28.3	88.0	300.4
Total	1,201.6	101.1	599.1	1,901.8

[7] Detailed tabulations for the 1970 land base, management activities, and resource outputs are shown in Appendix C.

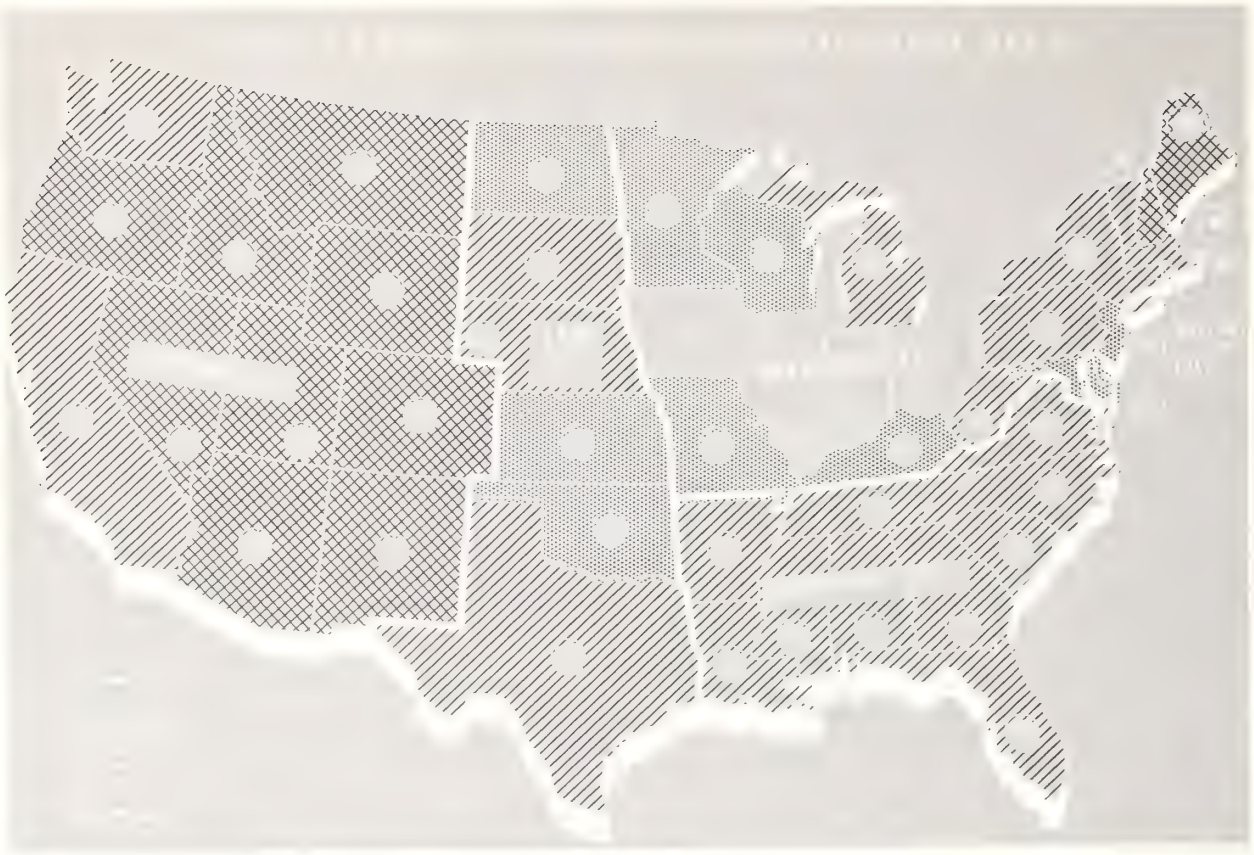

FIGURE 8.

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FIGURE 9.—Plains grasslands is the largest ecosystem.

Forest-range environment for the 48 States is made up of 34 ecosystems ranging in area from 173 million acres of Plains grasslands (fig. 9) to one million acres of Redwood (table 3). However, Plains grasslands, Oak-hickory (125 million), Sagebrush (94 million), Desert shrub (86 million), Mountain grasslands (80 million), and Loblolly-shortleaf pine (55 million) jointly comprise 613 million acres, or more than 50 percent of the total forest-range environment.

The Federal Government as an entity maintains jurisdiction over 373 million acres, or 31 percent of the forest-range lands, while the non-Federal owners control 829 million acres, or 69 percent of the total forest-range. Ownership by ecosystem, however, varies widely.

TABLE 3.—*Forest-range by ecosystem and ownership, 1970*

(Million acres)

[Totals may not add due to rounding]

Ecogroups and Ecosystems	National Forest System	Other Federal Land	Non-Federal Land	Forest-Range Environment
Western Range				
Sagebrush	10.0	67.2	17.1	94.2
Desert shrub	5.0	55.3	25.8	86.0
Southwestern shrubsteppe	1.1	10.3	27.2	38.6
Chapparal-mountain shrub	6.7	12.8	12.6	32.1
Pinyon-juniper	10.2	17.4	15.1	42.7
Mountain grasslands	7.2	5.6	67.0	79.8
Mountain meadows	1.9	0.1	2.0	4.0
Desert grasslands	1.2	9.6	15.3	26.1
Annual grasslands	0	0.4	6.3	6.7
Alpine[1]	8.3	T[2]	0	8.3
Total	51.6	178.8	188.2	418.6
Western Forest				
Douglas-fir	20.2	3.3	15.4	38.9
Ponderosa pine	19.2	1.6	16.7	37.6
Western white pine	3.5	0.1	0.5	4.1
Fir-spruce	18.4	1.8	4.2	24.4
Hemlock-Sitka spruce	2.2	0.5	4.4	7.1
Larch	3.3	0.2	1.7	5.1
Lodgepole pine	13.5	2.6	3.0	19.1
Redwood	T	0.1	0.9	0.9
Hardwoods	6.8	1.7	15.0	23.4
Total	87.1	11.9	61.7	160.6
Great Plains				
Shinnery	0.1	T	1.9	2.0
Texas savanna	T	0.1	15.1	15.2
Plains grasslands	3.6	6.8	162.9	173.3
Prairie	0.3	0.2	37.9	38.4
Total	3.9	7.1	217.9	228.9
Eastern Forest				
White-red-jack pine	1.5	0.1	10.9	12.6
Spruce-fir	2.2	0.2	21.2	23.6
Longleaf-slashpine	1.1	0.8	19.0	20.9
Loblolly-shortleaf pine	3.6	0.7	50.7	55.1
Oak-pine	2.2	0.7	31.6	34.5
Oak-hickory	6.8	2.0	116.2	125.1
Oak-gum-cypress	0.5	1.2	32.4	34.1
Elm-ash-cottonwood	0.3	0.2	24.5	25.0
Maple-beech-birch	2.7	0.2	32.8	35.6
Aspen-birch	2.4	0.2	20.0	22.6
Wet grasslands[3]	T	2.7	1.7	4.5
Total	23.3	9.0	361.1	393.5
48 State Total	165.9	206.8	828.9	1,201.6

[1] Includes barren areas above treeline.

[2] T=less than 50,000 acres.

[3] Occurs throughout much of coastal United States.

The USDA Forest Service, through the National Forest System, maintains jurisdiction over 14 percent, or 166 million acres of the forest-range. Although every ecosystem except Annual grasslands is represented in this land area, two-thirds is forested, and more than one-half is in the Western Forest ecogroup. Forest ecosystems over which the U.S. Forest Service has major control include: 85 percent of the Western white pine, 75 percent of the Fir-spruce, 71 percent of the Lodgepole pine, 65 percent of the Larch, 52 percent of the Douglas-fir, and 51 percent of the Ponderosa pine (fig. 10). National Forest System lands in the east are dispersed among all ecosystems and account for only 6 percent of the Eastern Forest ecogroup total.

The nonforest portion of the National Forest System is also concentrated in the western ecogroups. But with the exception of the Alpine ecosystem, where the U.S. Forest Service has jurisdiction over essentially all of the 8 million acres, the Forest Service share of the individual ecosystems involved is small. In absolute terms, however, 10 million acres each of Pinyon-juniper and Sagebrush, 8 million acres of Alpine, and 5 or more million acres each of Chaparral-mountain shrub, Mountain grasslands, and Desert shrub, plus lesser amounts

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FIGURE 10.—USDA Forest Service has jurisdiction over 51 percent of the Ponderosa pine ecosystem.

of other Western Range ecosystems, amount to 52 million acres—a sizable holding.

Other Federal ownership which includes Bureau of Land Management, National Park Service, Fish and Wildlife Service, and Bureau of Indian Affairs also is concentrated in the western ecogroups, but is composed primarily of the Western Range ecogroup. These other Federal agencies have jurisdiction over 186 million acres of range ecosystems, of which 96 percent is located in the west, and 21 million acres of forested lands, nearly equally divided between Eastern and Western Forests. In the Western Range ecogroup, Sagebrush and Desert shrub ecosystems account for 122 million acres or two-thirds of the other-Federal lands. Pinyon-juniper (17 million acres), Chaparral-mountain shrub (13 million acres), Southwestern shrubsteppe (10 million acres), and Desert grasslands (10 million acres) are other dominant ecosystem holdings of these other Federal agencies.

The non-Federal sector is concentrated in the Great Plains and Eastern Forest ecogroups. More than 95 percent of the Great Plains and 92 percent of the Eastern Forest ecogroups are in private ownership. The largest ecosystems are Plains grasslands and Oak-hickory, with 163 and 116 million acres, respectively, comprising 34 percent of the non-Federal lands

TABLE 4.—*Forest-range by productivity and condition and stand-size classes, 1970*

(Thousand acres)

[Totals may not add due to rounding]

Ecogroups and condition and stand-size classes	Productivity classes				Total
	High	Moderately high	Moderately low	Low	
Non-forested (condition)					
Western Range					
Good	9,693	20,963	39,101	4,063	73,820
Fair	6,110	35,457	109,501	58,312	209,380
Poor	673	5,347	26,195	103,210	135,425
Total	16,476	61,767	174,797	165,585	418,625
Great Plains					
Good	4,403	37,125	69,026	62	110,616
Fair	1,646	1,256	97,432	2,452	102,786
Poor	349	457	3,014	11,637	15,457
Total	6,398	38,838	169,472	14,151	228,859
Total non-forested	22,874	100,605	344,269	179,736	647,484
Forested (stand size)					
Western Forest					
Nonstocked	847	800	1,867	2,675	6,189
Seedling, sapling, & pole	5,994	4,116	10,124	27,386	47,620
Sawtimber	15,360	15,607	31,481	44,372	106,820
Total	22,201	20,523	43,472	74,433	160,629
Eastern Forest					
Nonstocked	483	1,726	5,669	10,717	18,595
Seedling, sapling, & pole	8,425	42,748	102,649	79,933	233,755
Sawtimber	11,509	41,013	55,780	32,831	141,133
Total	20,417	85,487	164,098	123,481	393,483
Total forested	42,618	106,010	207,570	197,914	554,112

and 23 percent of the total forest-range. Other large ecosystems in the non-Federal ownership are the 67 million-acre Mountain grasslands, the 51 million-acre Loblolly-shortleaf pine, and the 38 million-acre Prairie ecosystems. These five ecosystems make up 52 percent of the non-Federal lands and 36 percent of the total forest-range environment.

For all nonforested ecosystems, only one-fifth of the land was in the top two productivity classes (table 4). In the Western Range ecogroup, more than 50 percent of land in the highest classes was in the Sagebrush and Mountain grassland ecosystems, while in the Great Plains, 80 percent of the lands were in the Plains grasslands ecosystem. In terms of ownership, more than 40 percent of both National Forest System and other Federal lands was in the low productivity class, while about half of the non-Federal land was in the moderately low class (fig. 11). However, for the National Forest System lands, 14 percent was in the high categories compared to 3 percent for the other ownerships.

It was also estimated that 29 percent of the non-forested ecosystems were in good condition, 48 percent fair, and 23 percent poor. The largest proportion of good condition lands was in the Great Plains ecogroup, even though it accounts for only one-third of the nonforested area. Poor condition range was located mainly in the low productivity class of the Western Range Ecogroup. Ownership comparisons in terms of range condition were not reported because of the different standards used for the various ownerships.

Almost 45 percent of the forested ecosystems was in mature timber; about 51 percent was in seedlings, saplings, and poles, and about 4 percent was nonstocked. The Western Forest ecosystems have the largest share, 60 percent, in the mature timber class. These proportions varied by ownership: The National Forest System has the highest percentage of mature timber, 61 percent, and the lowest percent nonstocked, 3 percent.

MANAGEMENT STRATEGIES—1970

Of the 1,202 million acres of forest-range lands in the 48 States, 835 million, or 69 percent, was grazed by livestock in 1970. In terms of percentage, the Great Plains ecogroup has the largest percentage grazed, 95 percent, followed closely by the Western Range ecogroup with 86 percent (fig. 12). Percentage grazed also varied by ownership: 80 percent of the other Federal lands was grazed, followed by 69 percent of the non-Federal, and 61 percent for the National Forest System.

Approximately three-fourths, or 641 million acres, of the 835 million-acre total being grazed is currently under "some livestock" and extensive management systems (Strategies B and C); 58 million acres were managed intensively (Strategy D); and grazing output was maximized (Strategy E) on 50 million acres. Maximizing livestock grazing was concentrated in the Prairie, Mountain grasslands, and Plains grasslands ecosystems.

Application of management strategies varied in terms of ownership (fig. 13). Federal ownerships dominated in the lowest management intensity, Strategy B, with about one-third of the lands managed in this manner compared to 14 percent of the non-Federal lands. However, the highest intensity of management maximized livestock production, Strategy E, was reported to occur only on the non-Federal lands. Also, the non-Federal lands had the greatest proportion of exploitative management, 10 percent, compared to 2 percent for the Federal lands.

Intensity of grazing varied widely also among ecogroups (fig. 14). Percentagewise, more of the Eastern Forest was not grazed, 59 percent, while the highest proportion of maximized grazing (Strategy E), 14 percent, was reported in the Great Plains. Also, 72 million acres of exploitative grazing occurred in the Eastern Forest ecogroup. Here, 4.5 acres out of every 10 grazed were grazed exploitatively. The extent of this type of management was insignificant on the other ecogroups (fig. 15).

RESOURCE OUTPUTS—1970

The forest-range environment furnished 213 million animal unit months (AUM's) in 1970. This involved 196 million man-hours of work and $1.7 billion in terms of direct employment and animal output value (table 5).

While AUM output was spread nationwide, 70 percent was furnished in the Great Plains and Western Range ecogroups (fig. 16). The Eastern Forest ecogroup provided 25 percent, and the remaining 5 percent came from the Western Forest.

Two ecosystems in the Great Plains ecogroup, Plains grasslands and Prairie, produced 51 and 37 million AUM's, respectively. Thus these two ecosystems accounted for 41 percent of 213 million AUM total. Other ecosystems contributing in a major way to the national total include Mountain grasslands and Sagebrush in the Western Range and Oak-hickory and Longleaf-slash pine in the Eastern Forest. Together these six ecosystems accounted for two-thirds of the national AUM production for the forest-range environment.

The greater part of the AUM production occurred on the non-Federal lands. This sector furnished 183 million or 86 percent of the

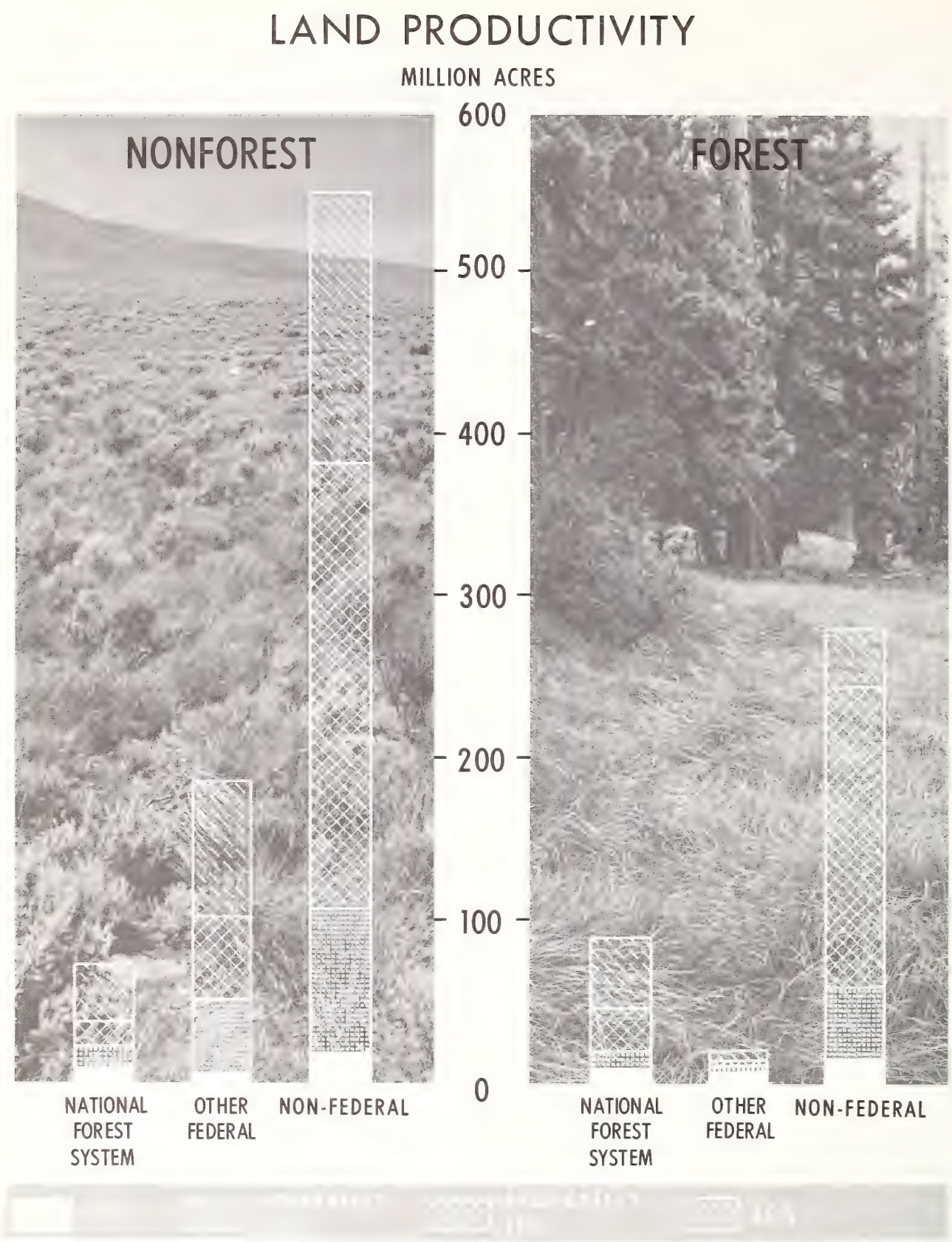
LAND PRODUCTIVITY
MILLION ACRES
NONFOREST
FOREST
600
500
400
300
200
100
0
NATIONAL FOREST SYSTEM
OTHER FEDERAL
NON-FEDERAL
NATIONAL FOREST SYSTEM
OTHER FEDERAL
NON-FEDERAL

FIGURE 11.

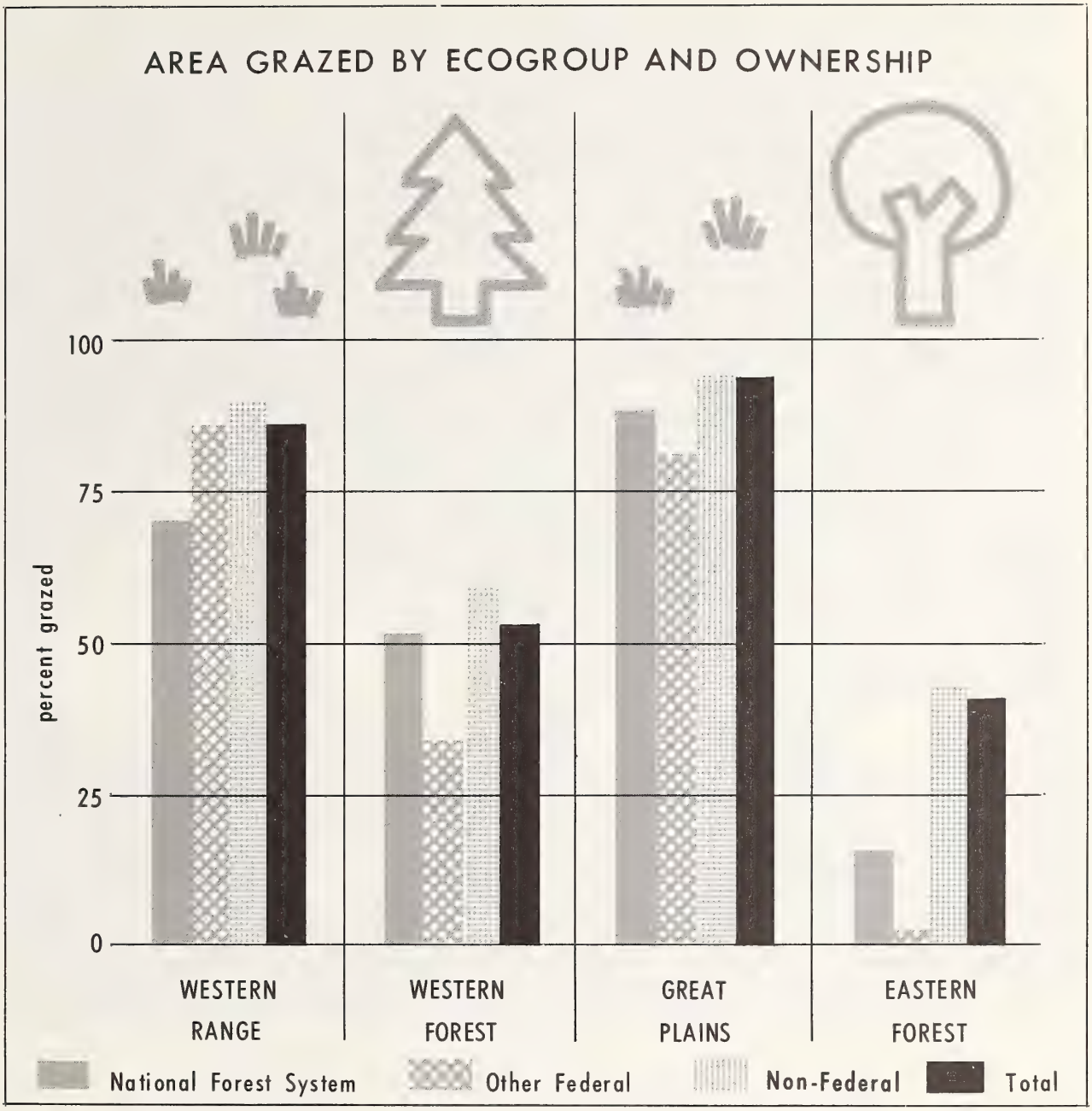
AREA GRAZED BY ECOGROUP AND OWNERSHIP
100
75
50
25
0
percent grazed
WESTERN RANGE
WESTERN FOREST
GREAT PLAINS
EASTERN FOREST
National Forest System
Other Federal
Non-Federal
Total

FIGURE 12.

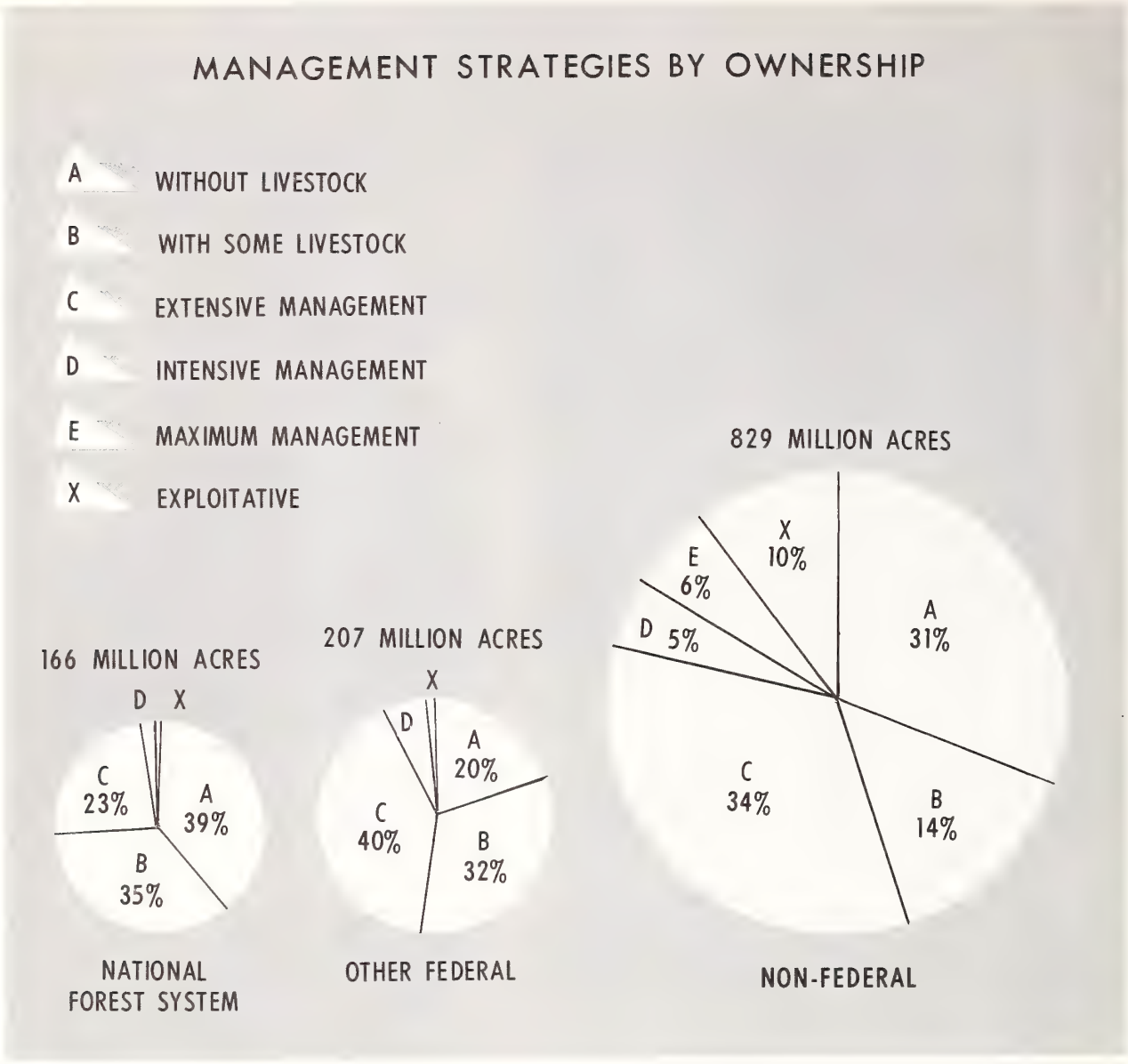
MANAGEMENT STRATEGIES BY OWNERSHIP
A WITHOUT LIVESTOCK
B WITH SOME LIVESTOCK
C EXTENSIVE MANAGEMENT
D INTENSIVE MANAGEMENT
E MAXIMUM MANAGEMENT
X EXPLOITATIVE
166 MILLION ACRES
D X
C 23%
A 39%
B 35%
NATIONAL FOREST SYSTEM
207 MILLION ACRES
X
D
A 20%
C 40%
B 32%
OTHER FEDERAL
829 MILLION ACRES
X 10%
E 6%
D 5%
A 31%
C 34%
B 14%
NON-FEDERAL

FIGURE 13.

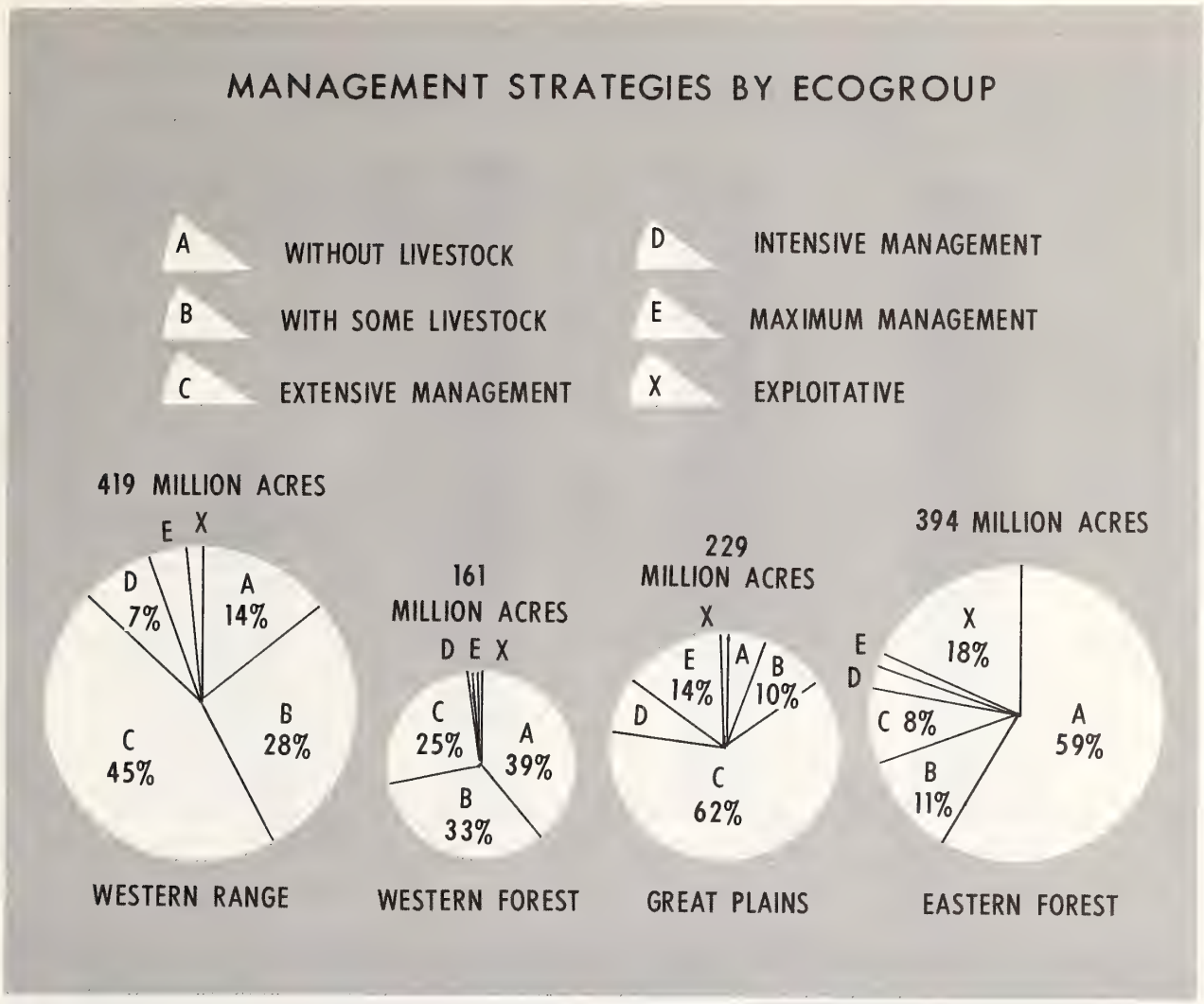
MANAGEMENT STRATEGIES BY ECOGROUP
A WITHOUT LIVESTOCK
B WITH SOME LIVESTOCK
C EXTENSIVE MANAGEMENT
D INTENSIVE MANAGEMENT
E MAXIMUM MANAGEMENT
X EXPLOITATIVE
419 MILLION ACRES
E X
D 7%
A 14%
B 28%
C 45%
WESTERN RANGE
161 MILLION ACRES
D E X
C 25%
A 39%
B 33%
WESTERN FOREST
229 MILLION ACRES
X
E 14%
A
B 10%
D
C 62%
GREAT PLAINS
394 MILLION ACRES
X 18%
E
D
C 8%
A 59%
B 11%
EASTERN FOREST

FIGURE 14.

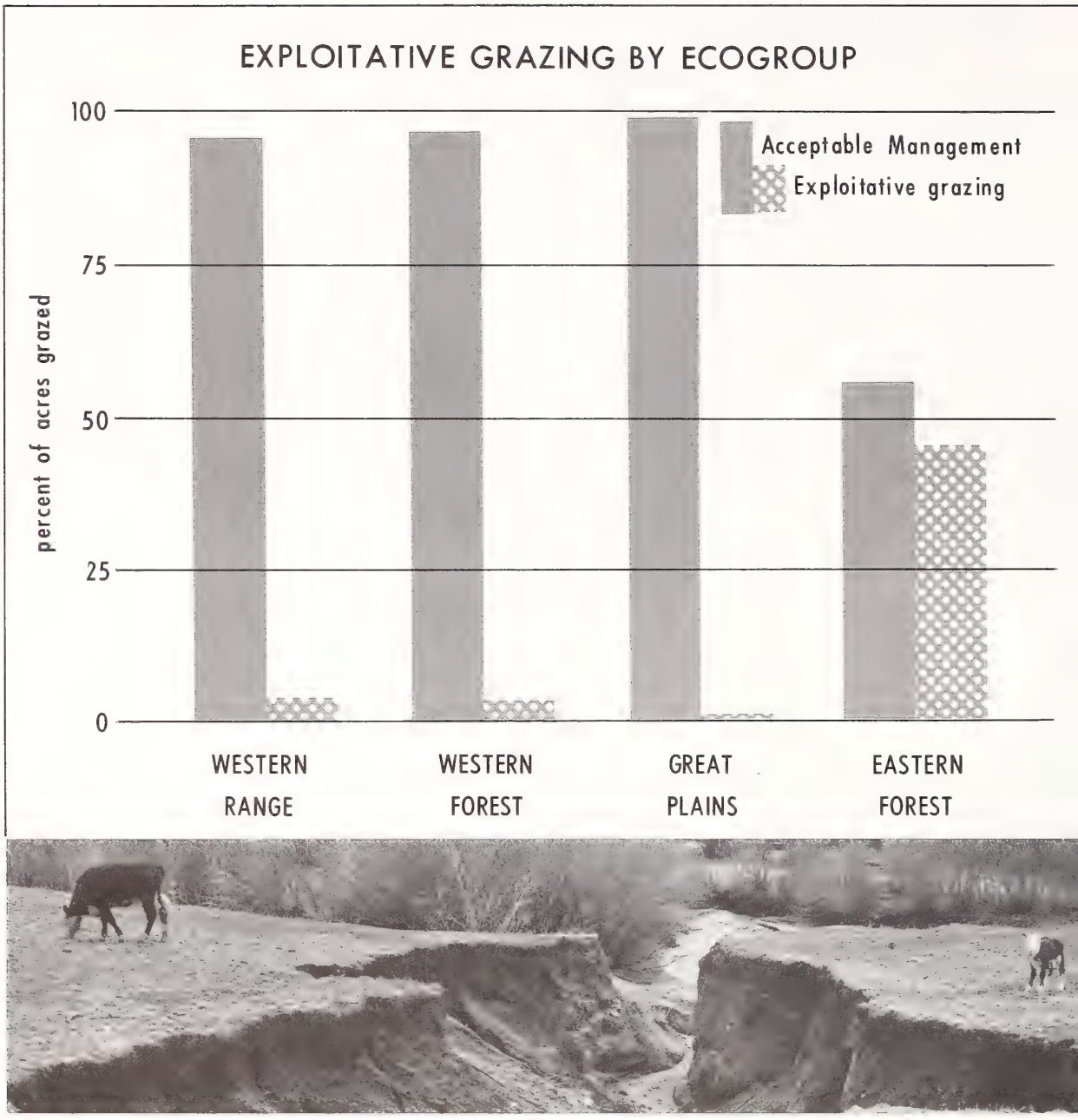
EXPLOITATIVE GRAZING BY ECOGROUP
100
75
50
25
0
percent of acres grazed
Acceptable Management
Exploitative grazing
WESTERN RANGE
WESTERN FOREST
GREAT PLAINS
EASTERN FOREST

FIGURE 15.

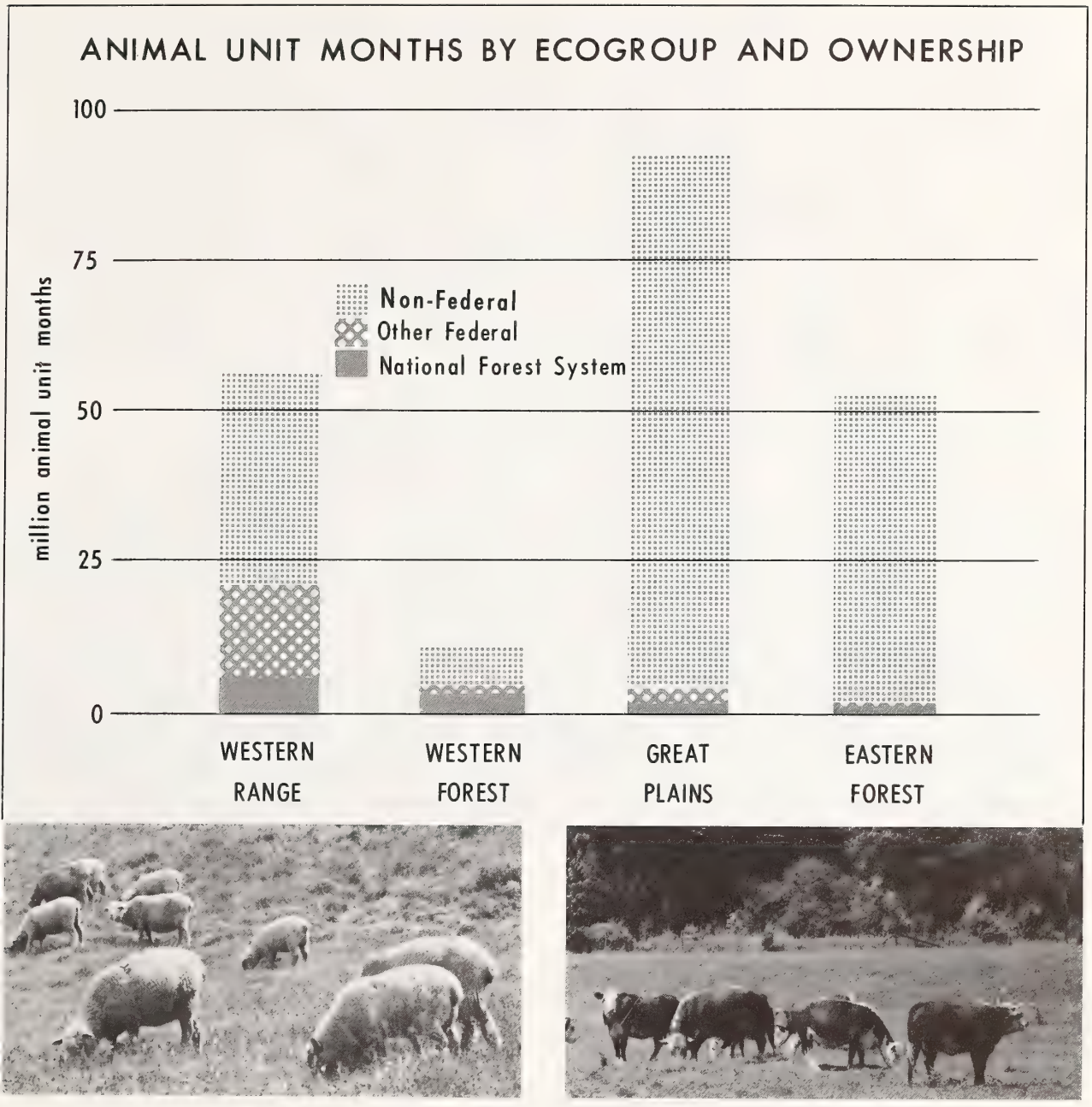
ANIMAL UNIT MONTHS BY ECOGROUP AND OWNERSHIP
100
75
50
25
0
million animal unit months
Non-Federal
Other Federal
National Forest System
WESTERN RANGE
WESTERN FOREST
GREAT PLAINS
EASTERN FOREST

FIGURE 16.

TABLE 5.—*Employment and animal output value from livestock grazing by ownership and ecogroup, 1970*
(Totals may not add due to rounding)

Ownership	Western Range	Western Forest	Great Plains	Eastern Forest	Total
	Employment				
	Million man-hours per year	*Million man-hours per year*	*Million man-hours per year*	*Million man-hours per year*	*Million man-hours per year*
National Forest System	8.3	3.1	1.0	0.7	13.0
Other Federal	19.5	0.5	2.2	0.1	22.3
Non-Federal	40.7	6.5	80.3	32.6	160.2
All ownerships	68.5	10.1	83.5	33.4	195.5
	Animal Output Value				
	Million dollars	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*
National Forest System	45.0	26.1	8.4	7.1	86.5
Other Federal	126.1	4.7	18.3	1.0	150.1
Non-Federal	288.9	55.2	747.8	358.4	1,450.3
All ownerships	460.0	86.0	774.5	366.5	1,687.0

AUM's from 68 percent of the land grazed (fig. 17). The National Forest System provided 5 percent of the animal unit months from 12 percent of the land grazed, and other Federal lands provided 9 percent from 20 percent of the land.

Of the 213 million animal unit months provided, 99 million or almost half were produced under extensive management (Strategy C); 45 million under maximum management (Strategy E); 26 million under intensive management (Strategy D); 25 million under some livestock (Strategy B); and 18 million under exploitative (Strategy X).

Average production from all forest-range lands grazed was approximately four acres per AUM or 0.26 AUM per acre (fig. 18). Assuming a five month grazing season, this was an average of about 20 acres per animal unit per grazing season. However, production averages varied from 9 acres per AUM for both National Forest System and other Federal lands to about 3 acres on non-Federal lands. These differences in relative productivity can be explained largely by the variation in management mixes and ecosystem ownership patterns. To get one animal unit month under the lowest level of livestock management, Strategy B required 9.5 acres, while only 1.1 acres were needed under Strategy E, maximized livestock production. This had a major influence on the ownership average since 16 percent of the grazed non-Federal land was managed intensively, Strategies D and E, compared to 8 percent for other Federal and 3 percent for the National Forest System. In addition, 9.1 acres of Western Forest land and 6.4 acres of Western Range were required to produce one animal unit month compared to 2.3 acres for the Great Plains and 3.0 acres for the Eastern Forest. This also increased the Federal average because of the large amount of land grazed in the western ecogroups under Federal ownership.

Forest-range lands were also highly productive for a wide variety of other products. In terms of herbage and browse production, forest-range lands nationwide provided 485 million tons yearly. The Great Plains ecogroup was the most productive, yielding 155 million tons or 0.7 ton per acre (fig. 19). The Western Range produced 145 million tons; Eastern Forest 133 million tons; and Western Forest 52 million tons. All three of these ecogroups averaged about 0.3 ton per acre.

For individual ecosystems the Wet grasslands was the most productive, yielding more than 2.5 tons of herbage per acre. Other leading ecosystems include Aspen-birch, Mountain meadows, Annual grasslands, and Prairie, all yielding more than 1 ton per acre annually. The average for all ecosystems was 0.4 ton per acre.

It was also estimated that the annual net wood growth for forest-range lands was 20.5 billion cubic feet (fig. 20). This figure differs from volume normally reported for commercial forest land because the study includes areas of noncommercial forest which is primarily composed of nonproductive and productive reserves. The major contributor was non-Federal lands

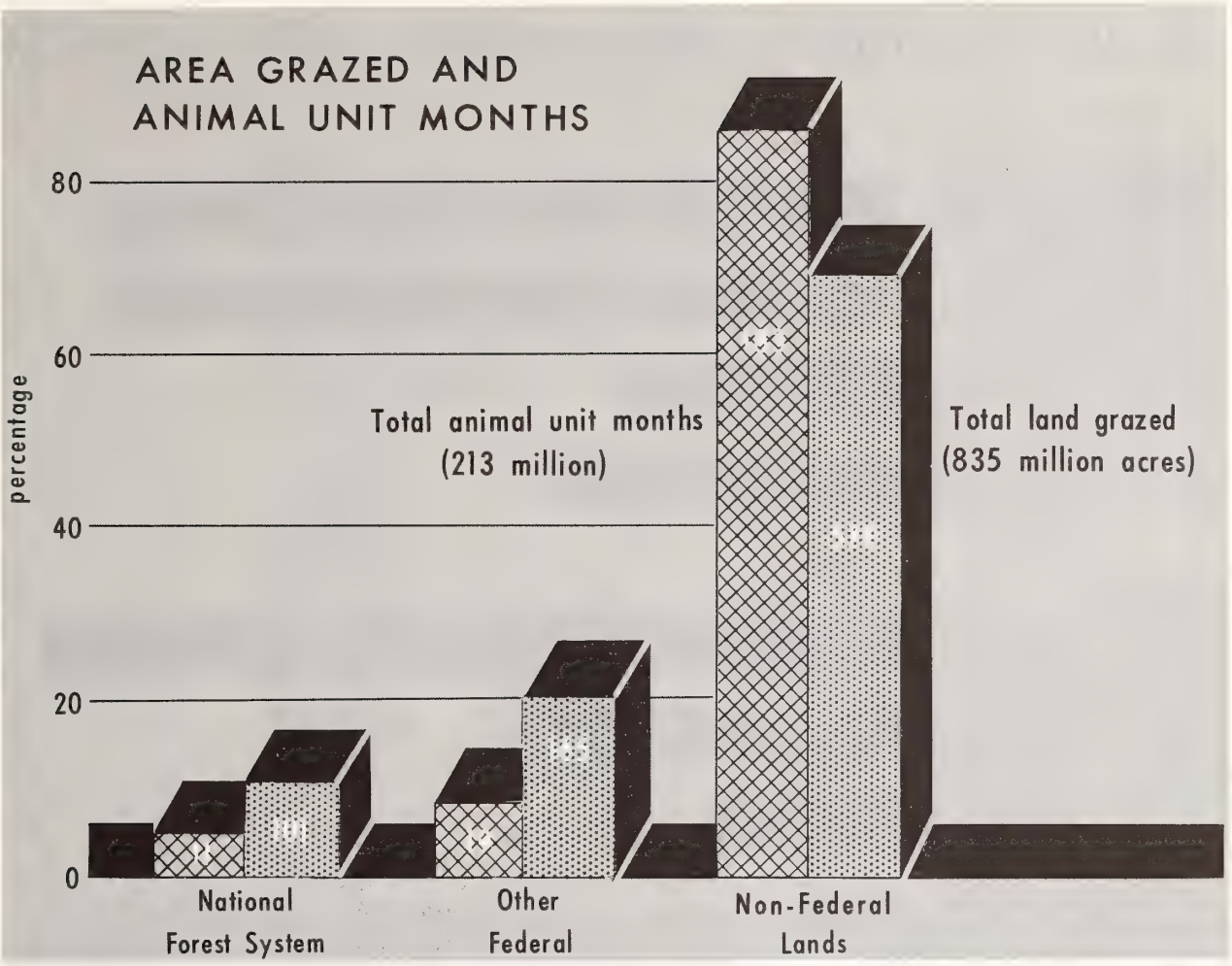
AREA GRAZED AND
ANIMAL UNIT MONTHS
80
60
40
20
0
percentage
Total animal unit months
(213 million)
Total land grazed
(835 million acres)
National
Forest System
Other
Federal
Non-Federal
Lands

FIGURE 17.

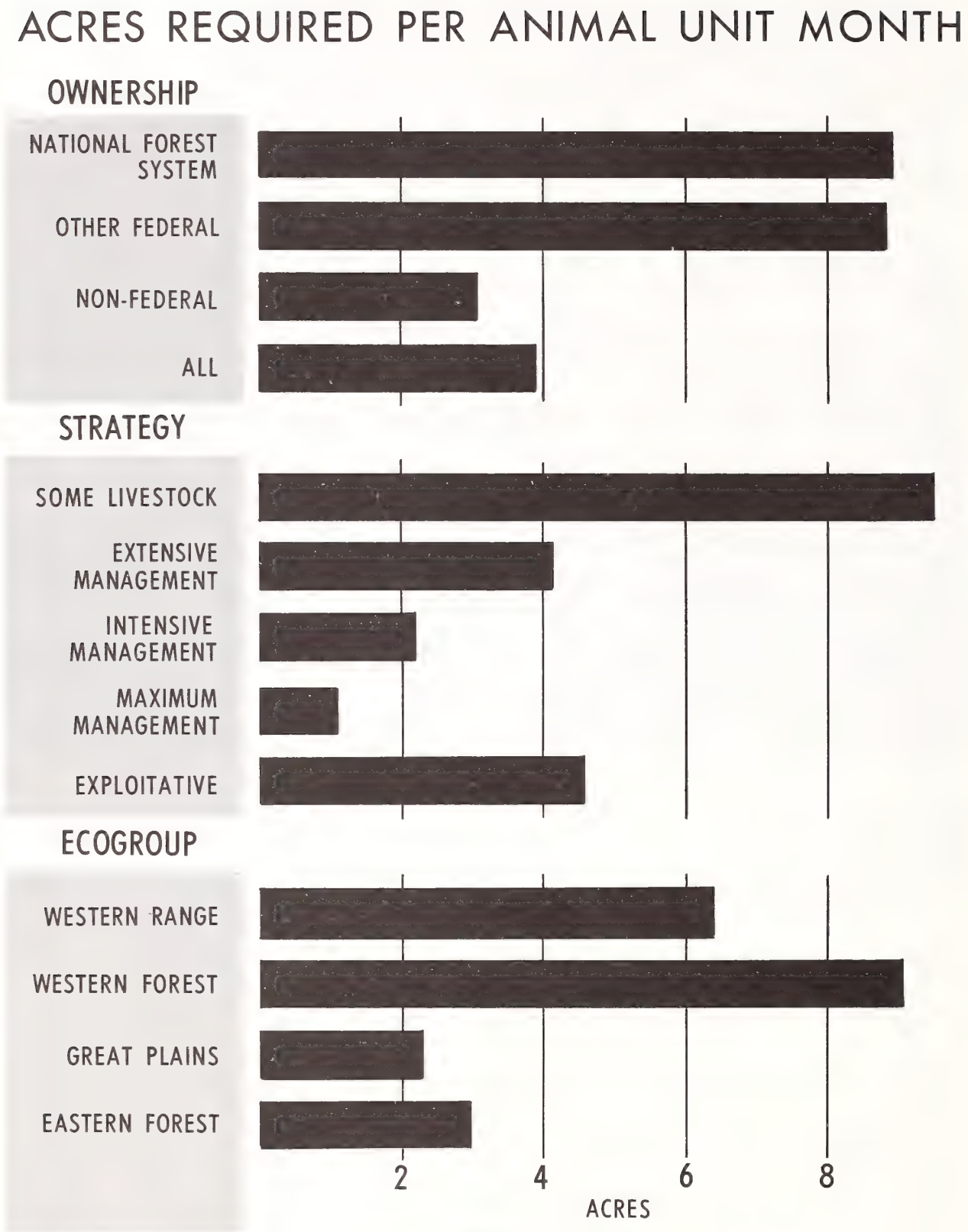
ACRES REQUIRED PER ANIMAL UNIT MONTH
OWNERSHIP
NATIONAL FOREST SYSTEM
OTHER FEDERAL
NON-FEDERAL
ALL
STRATEGY
SOME LIVESTOCK
EXTENSIVE MANAGEMENT
INTENSIVE MANAGEMENT
MAXIMUM MANAGEMENT
EXPLOITATIVE
ECOGROUP
WESTERN RANGE
WESTERN FOREST
GREAT PLAINS
EASTERN FOREST
2
4
6
8
ACRES

FIGURE 18.

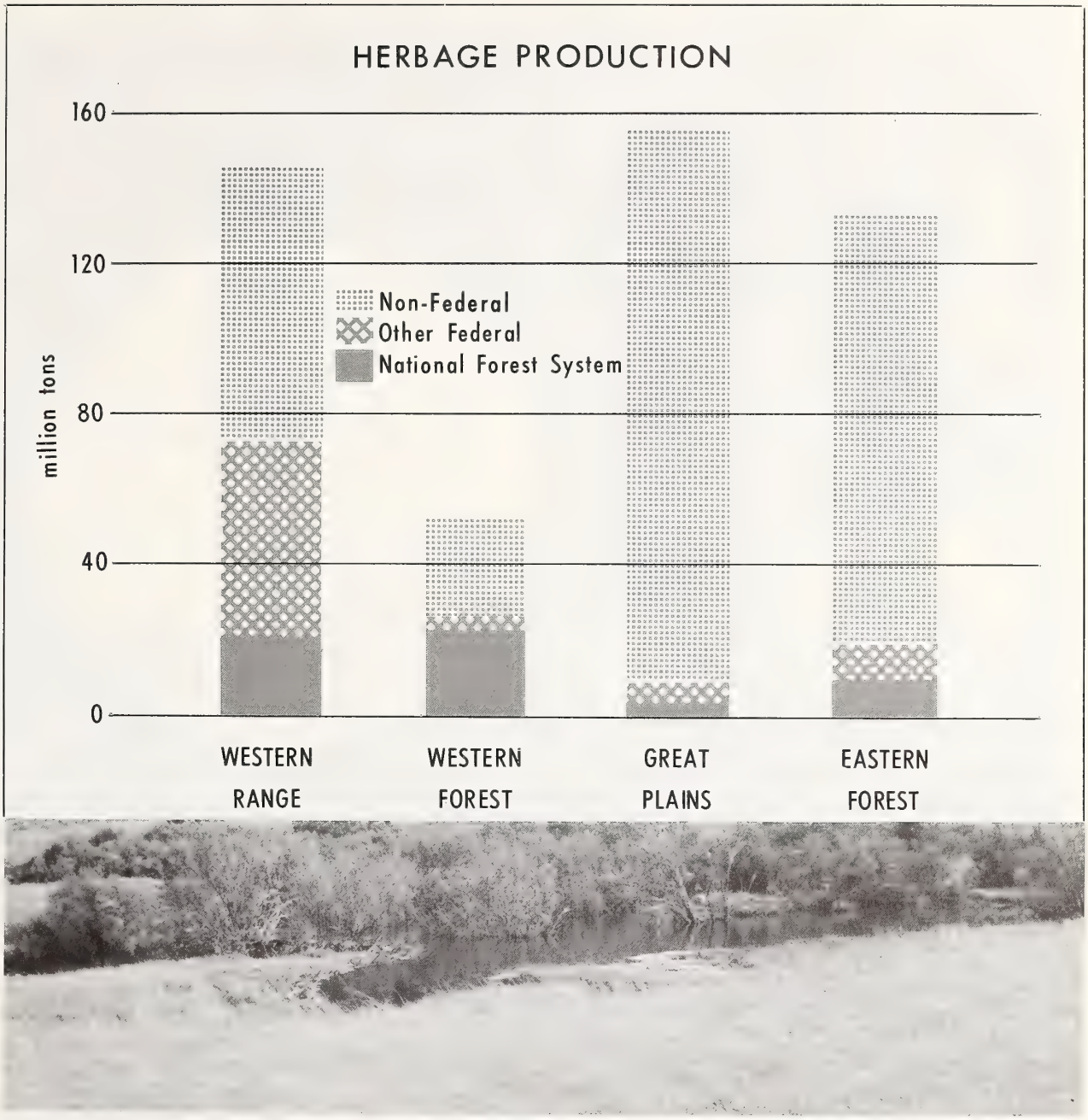
HERBAGE PRODUCTION
160
120
80
40
0
million tons
Non-Federal
Other Federal
National Forest System
WESTERN RANGE
WESTERN FOREST
GREAT PLAINS
EASTERN FOREST

FIGURE 19.

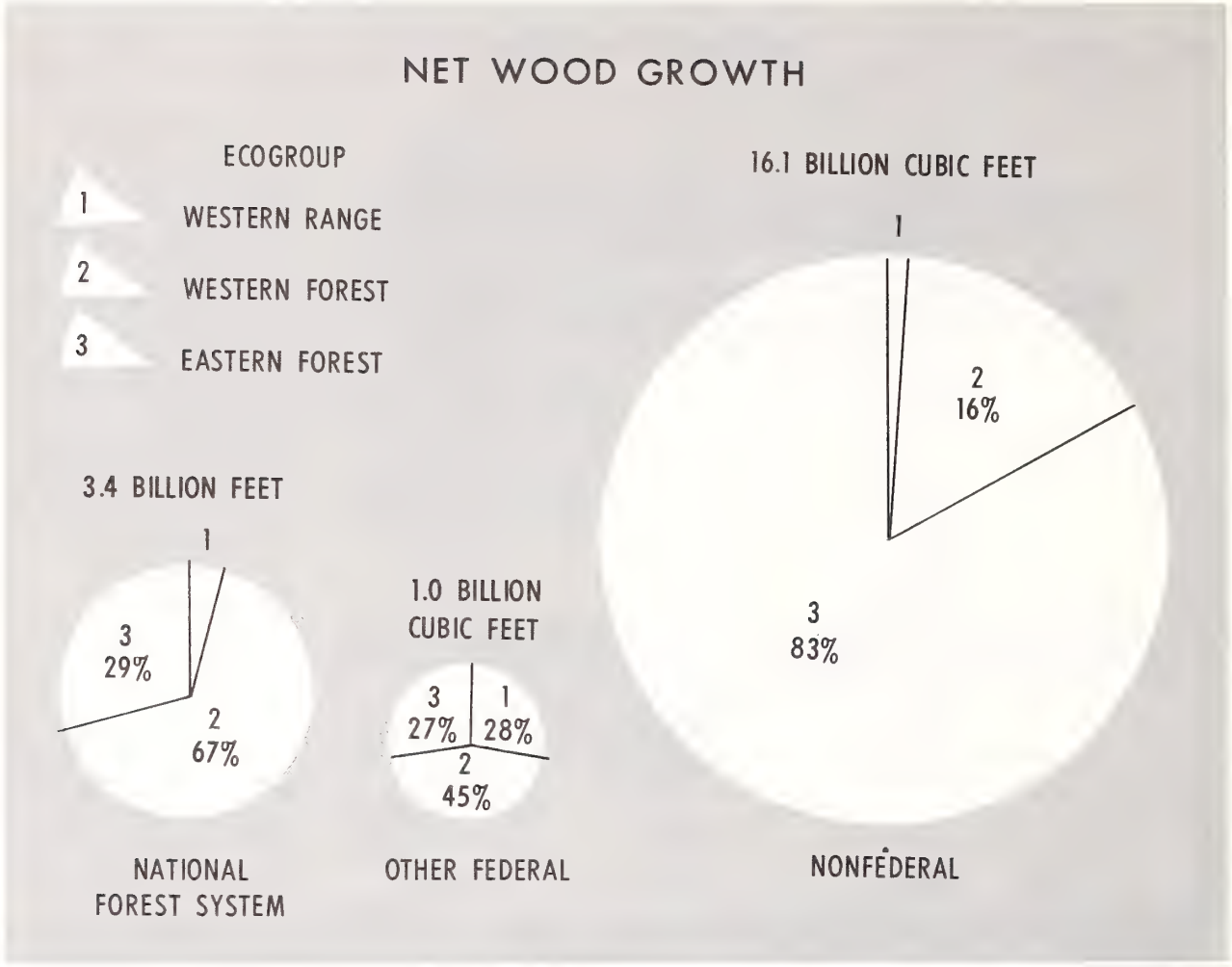

FIGURE 20.

in the Eastern Forest ecogroup, accounting for 64 percent of national total. About half of this production took place in Oak-hickory and Loblolly-shortleaf pine ecosystems. However, on a per acre basis, productivity of the Western Forest ecogroup was about equal to that of the Eastern Forest. Average growth per acre on Western Forest lands was an estimated 36.5 cubic feet compared to 34.1 cubic feet on the Eastern Forest.

Water production was estimated at 780 million acre feet, of which 90 percent met quality standards (fig. 21). On a per acre basis, this amounted to 0.65 acre foot per year for all forest-range lands (table 6). The national average is about 0.75 acre foot. The Eastern Forest was the most productive, yielding 62 percent of the water while contributing low amounts of sediment. But as with the wood yields, per acre water yields on Western and Eastern Forest ecogroups were essentially equal. The Eastern Forest water yield was 1.24 acre feet of water while contributing 0.43 ton sediment per acre compared to 1.10 acre feet of water and 0.52 ton of sediment per acre for Western Forest. These yields contrast markedly with range ecogroups where water yields were low and sediment deposits sizable. The Western Range water yield was 0.24 acre foot of water and 2.74 tons per acre of sediment; the Great Plains water yield was 0.08 acre foot of water and 1.12 tons per acre of sediment.

Reviewing the wood and water data for only the National Forest System, however, presents a different picture. National Forest System Western Forest ecogroup yields slightly more

TABLE 6.—*Acre rates for hydrologic outputs by ecogroup and ownership, 1970*

Ownership by ecogroup	Water yield	Quality water	Storm runoff	Sediment
	Acre feet per year	*Acre feet per year*	*Inches per acre per year*[1]	*Tons per acre per year*
National Forest System				
Western Range	0.65	0.64	0.31	3.10
Western Forest	1.00	0.96	0.30	0.36
Great Plains	0.04	0.02	0.88	0.76
Eastern Forest	1.24	1.24	0.90	0.01
Weighted average	0.90	0.88	0.40	1.17
Other Federal				
Western Range	0.11	0.11	0.26	3.34
Western Forest	1.10	1.06	0.62	0.58
Great Plains	0.04	0.02	0.79	0.76
Eastern Forest	1.16	1.16	2.94	0.05
Weighted average	0.21	0.21	0.41	2.95
Non-Federal				
Western Range	0.25	0.22	0.38	2.08
Western Forest	1.23	1.17	0.62	0.73
Great Plains	0.08	0.03	0.71	1.14
Eastern Forest	1.24	1.10	1.36	0.47
Weighted average	0.71	0.62	0.91	1.03
All ownership				
Western Range	0.24	0.23	0.32	2.74
Western Forest	1.10	1.05	0.44	0.52
Great Plains	0.08	0.03	0.72	1.12
Eastern Forest	1.24	1.11	1.37	0.43
Weighted average	0.65	0.59	0.76	1.38

[1] Runoff expected from a 2-year 2-day storm.

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FIGURE 21.—Quality water, scenic beauty, and clean air express high quality environment.

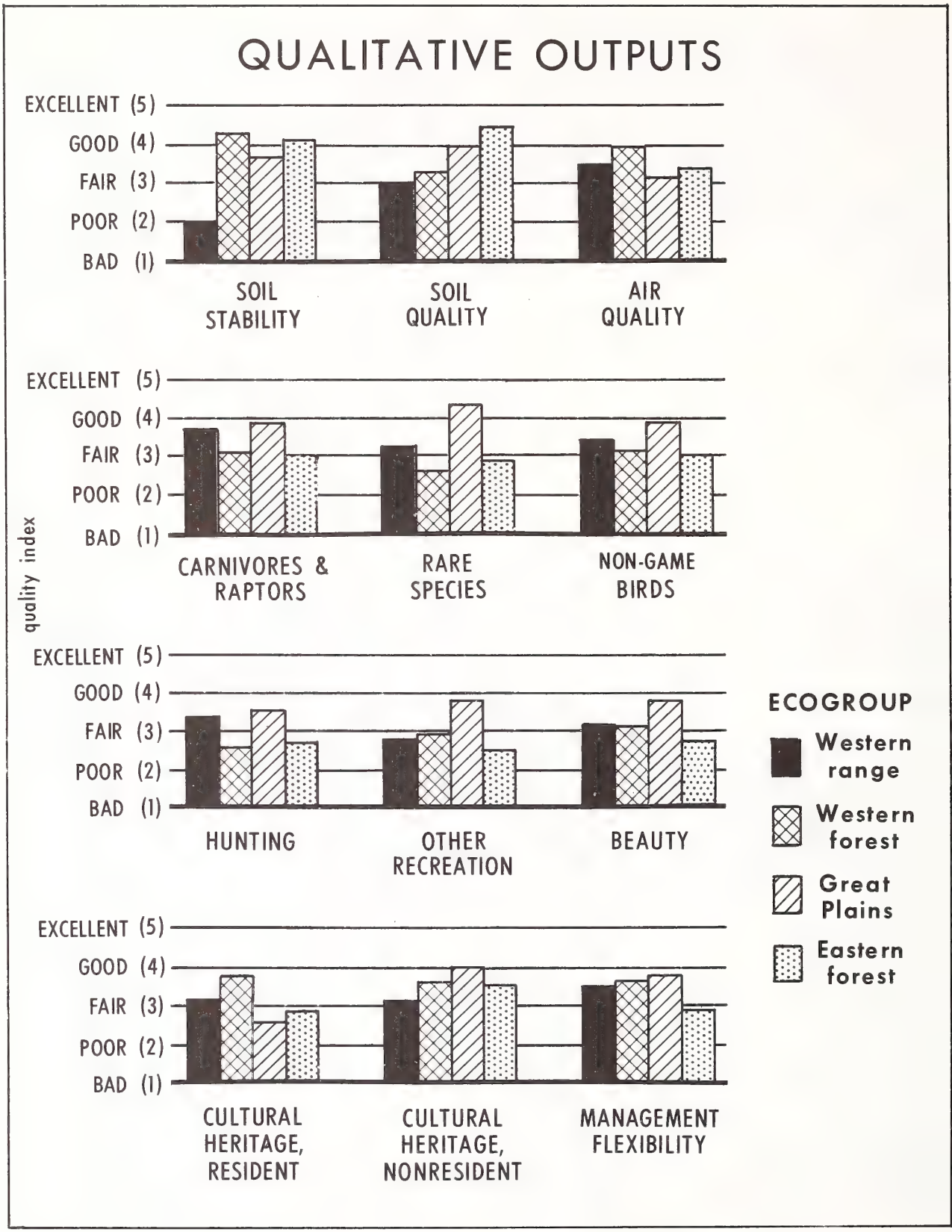
QUALITATIVE OUTPUTS
EXCELLENT (5)
GOOD (4)
FAIR (3)
POOR (2)
BAD (1)
quality index
SOIL STABILITY
SOIL QUALITY
AIR QUALITY
CARNIVORES & RAPTORS
RARE SPECIES
NON-GAME BIRDS
HUNTING
OTHER RECREATION
BEAUTY
CULTURAL HERITAGE, RESIDENT
CULTURAL HERITAGE, NONRESIDENT
MANAGEMENT FLEXIBILITY
ECOGROUP
Western range
Western forest
Great Plains
Eastern forest

FIGURE 22.

than twice the amount of wood and 160 times more sediment than does the Eastern Forest ecogroup. Also, the Western Forest ecogroup in the National Forest System produces about three times more water than the Eastern Forest ecogroup in the National Forest System. About 40 percent of this water yield from the Western Forest comes from the Fir-spruce ecosystem although it accounts for only 20 percent of the acreage in National Forest System forest lands. The Alpine ecosystem is another major water source, contributing 15 percent of the water yield from the National Forest System lands.

Qualitative outputs for the forest-range lands were principally rated fair to good for all ecogroups (fig. 22). One major exception above the norm was the lesser soil stability in the Western Range, exemplified by high sediment yields.

SUMMARY

This study estimated that 1.2 billion acres, or 63 percent, of the total land area in the 48 conterminous United States is in forest-range environment. It was estimated that 835 million acres, or 69 percent, was grazed by livestock in 1970.

The 11 western States dominated, both in terms of total area and proportion of land in forest-range. However, the Great Plains ecogroup had the largest percentage of forest-range land grazed, 94 percent, followed closely by the Western Range ecogroup, with 88 percent.

About three-fourths of the grazed land was managed for livestock at extensive levels. Maximizing for livestock production occurred on about 50 million acres and was concentrated in the Prairie, Plains grasslands, and Mountain grasslands ecosystems. Exploitative grazing was occurring on 72 million acres of the Eastern Forest ecosystems.

It was estimated that the Nation's forest-range resource produced 213 million animal unit months in 1970. While AUM output was spread nationwide, 70 percent was furnished in the Great Plains and Western Range ecogroups. A majority of the AUM production was on non-Federal lands.

Forest-range lands were also highly productive for a wide variety of other products. It was estimated that the average acre of forest-range produced 0.4 ton of herbage and browse and 0.65 acre foot of water yearly. It was also estimated that annual net wood growth on the forest-range land was 20.5 billion cubic feet. Qualitative outputs were principally rated fair to good for all ecosystems.

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Water Resources Council
1968. The Nation's Water Resources. Washington, D.C. U.S. Government Printing Office

Chapter III

DEMAND FOR OUTPUTS OF THE FOREST-RANGE ENVIRONMENT

This chapter focuses on the demand for outputs of the forest-range environment. In addition to the demand for forest-range grazing, estimates of demand for many other forest-range outputs are considered. The attempt has been made to foresee the trends in both the economic and political demands America will put on her lands by 1980 and 2000 and the resultant implications for the forest-range environment.

The demand situation presented here should be considered in relation to the information on production in Chapter II, Resource Situation—1970. In addition, the 1970 resource information served as the basis for deriving reasonable production targets that are used in structuring the alternatives discussed in Chapter V, Analysis of Alternative Mixtures of Resource Use.

DEMAND CONCEPTS

Outputs of the forest-range environment vary considerably. Some are amenity considerations, while others are economic goods and services. Some are bought and sold in organized markets while others are nonmarket goods and services. This heterogeneity precludes simple calculation or computation of demands, but provides a framework for considering a spectrum of consequences of alternative policies.

Emphasis in this study has been given to the outputs for which there is economic demand. These are animal unit months of livestock grazing, wood growth, and water.

However, it was considered that management of the forest-range should be directed toward meeting society's needs for the many other resources offered by forest-range. Some outputs for which there is presently not a demand in the economic sense, but which have high environmental or social values, also are included. Among these are beauty, cultural heritage, rare and endangered animal species, and non-game birds. In their entirety, the 22 outputs used in this study represent a spectrum of economic, environmental, and social values.

Meeting society's needs for forest-range outputs will be a challenge to the Nation's resource managers and research scientists. Increasing population, a shorter work week with more leisure time, plus indications of more concern by the people for the natural environment, intensify the problem. The capability of the forest-range environment to produce many of these outputs is discussed in later chapters. How levels of range management affect the mixture of outputs will be shown. Each management system, production technique, or practice applied to the resource modifies the quantity and quality of the individual outputs.

Choice of management practices must be based on some knowledge of the demand of individuals, groups, corporations, government, or the general public for the possible outputs. In the short term, many demands are obvious and the resource manager can implement practices toward meeting the demand. Long-term

resource demands are less obvious, but it is important that some estimates of these be made so that management direction can properly be set. A long-range investment program cannot be justified unless there is reasonable expectation that demand for the benefits or outputs of that program will continue through the life of the investment.

The manager, whether he is a private individual or corporation, or government agency, must produce outputs to meet the market's demands, whether the output is timber sold for cash or bird-watching provided free to the user. The use must exist to complete the transaction and justify the management. Thus, the purpose of the demand analyses in the study has been to provide information from which to establish demand targets for use in structuring management alternatives.

The procedure used was to obtain the best information available about the probable range of future demands for use in producing policy alternatives that encompass these needs. Demands described in the report are based on the best information available. No detailed "demand analyses," *per se*, were attempted in the present effort. Demand as used here constitutes estimates of future needs and does not involve the price schedules required for demand analysis in the economic sense.

OUTLOOK FOR DEMANDS

Outlook for demands has been developed within the context of the commitments of the Nation to stewardship of basic resources, to maintenance or enhancement of environmental quality, to production of foods and services, and to social needs.

ECONOMIC OUTLOOK

The state of the Nation's economy will influence the management and use of the forest-range environment. The economic situation on which projected needs and opportunities for management of the forest-range environment are based, is briefly outlined here.

The projected population of 281 million people in the year 2000 is about 1.3 times the 1970 population [8] (fig. 23). The general economy is assumed to remain stable and productive. Production value per man-hour in the year 2000 will be nearly two and one-half times what it was in 1970. The economy is expected to yield a Gross National Product (GNP) of $1,152 billion in 1980 and of $2,350 billion in 2000. The GNP will more than double in the 20 years between 1960 and 1980, and will increase by more than five times between 1980 and 2000 (table 7).

TABLE 7.—*Selected national aggregates as indicators of the United States economy* [1]

Year	Total population[2]	Product per man-hour in 1958 dollars[3]	Gross National Product in 1958 dollars	Personal income per capita in 1958 dollars
	Million people	*Dollars*	*Million dollars*	*Dollars*
1950	152	2.78	355,288	1,805
1960	181	3.68	487,682	2,134
1968	201	4.93	707,608	3,020
1970	205	([4])	([4])	([4])
1980	228	7.03	1,152,000	4,112
2000	281	12.69	2,350,000	7,161

[1] Data developed from materials prepared by Office of Business Economics, U.S. Dept. of Commerce, for U.S. Water Resource Council, 1968.

[2] Bureau of Census makes population projections at six levels, B, C, D, E, F, and X. "B" is the highest; "X" is the lowest projection level. The projections used here are based on Bureau of Census, level "D" from Current Population Reports, Series P-25, No. 448. Level "D" is slightly lower than the level used in studies prior to this report. Also see U.S. Bureau of Census, Current Population Reports, series P-25, No. 470, "Projections of the Population of the United States, by Age and Sex: 1970 to 2020," U.S. Government Printing Office, for discussion of current revisions in population projections.

[3] Value of production per man-hour worked in the private sector of the economy.

[4] Not available.

Prospects for population growth vary by region. The Western States will about triple in population. The Northeast, growing slower than the Nation, will not quite double its population. The Plains and Southeast are expected to add population at about the national average rate.

Agricultural prices were assumed to fall below those of the 1964–69 level. This stems from a prior assumption that the government will decrease agricultural production control programs and provide support prices at 65 percent of the parity level established in 1959–1961. With lower price supports and fewer production controls, the prices for primary field crops (especially feeds) will be lower, but the release of land will permit expanded production. The overall agricultural price framework will retain 1964–1969 internal price relationship at levels slightly lower than the rest of the economy. Nonagricultural segments of the

[8] Mounting concerns about population growth make any one population projection suspect. Success in achieving a national goal of two children per family, were this to be a national policy on population growth, would result in a year 2000 population of 271 million; a 3-child family—322 million (Domestic Council Committee on National Growth, 1972).

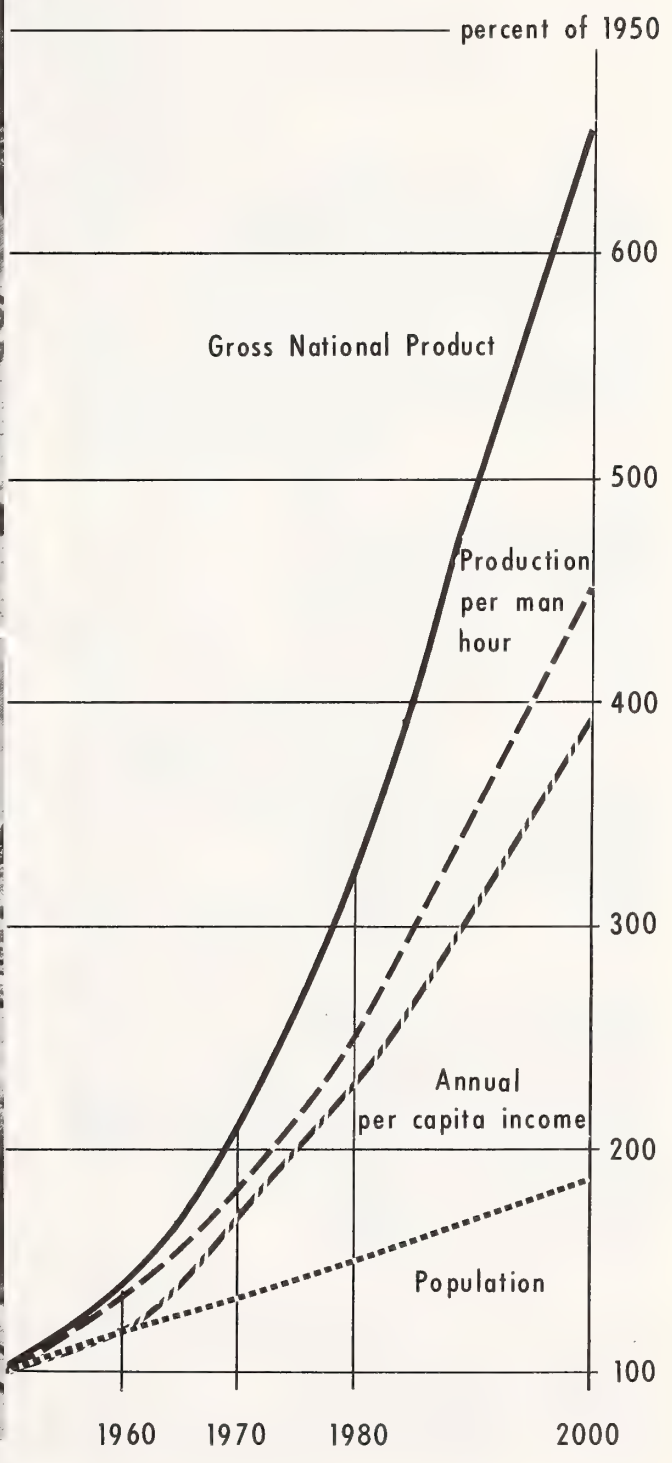
POPULATION
AND ECONOMIC GROWTH
percent of 1950
600
500
400
300
200
100
Gross National Product
Production
per man
hour
Annual
per capita income
Population
1960
1970
1980
2000

FIGURE 23.

economy are assumed to retain the basic relationship for the 1964–69 period.

POLITICAL-SOCIAL OUTLOOK

Noneconomic developments will also influence policies and programs for forest-ranges. We can expect educated, informed people to participate more actively in the political process than ever before. The balance of influence will shift. The clientele interested in th forest-range will broaden. Where dialogue formerly has been primarily with direct users of intermediate outputs (e.g., timber and animal unit months of grazing), the future will see more involvement with consumers of final outputs and with people interested in the quality of environment and human life.

New social and political concerns are not passing fads. Nor is the concern over pollution and other environmental degradation ephemeral. Basic political and social changes may be expected. These changes will materially affect management of natural resources, including those of the forest-range. Environmental quality is one form of "public goods and services" that generally will have to be provided for more adequately in decisions by individuals, private firms, and government.

Foreign trade in livestock products from forest-range is a potentially important variable, and revisions of import and export policies could lead to increases or decreases in total domestic production. Nonetheless, it has been assumed that foreign policy will not undergo a major change.

DEMANDS FOR OUTPUTS

Outputs from the forest-range environment are numerous and varied. This study has dealt with the 22 named in Chapter I, Inventory Concepts and Procedures, and mentioned in part in the introduction to this chapter. The choice in this analysis was to be inclusive but to use the terms and outputs most common to forest-range in a multiple-use context. Therefore, demands were expressed for livestock grazing and for such nongrazing outputs as timber, water, and environmental quality. The emphasis is on livestock grazing with only trend indicated for the other outputs.

LIVESTOCK GRAZING

Grazing of livestock (expressed here in animal unit months) is an intermediate output from forest-range. Range livestock production, operating within the context of total production of livestock, will share the fate of the rest of agriculture. Consideration, therefore, is given to the outlook for livestock production and its implications for grazing for forest-range (fig. 24).

Projected growth in population and income will continue to expand markets for farm products. Rising incomes will permit shifts in the composition of human diets. More foods of higher value, such as meat, will be consumed. Despite alternative sources of protein for human diets, livestock products will continue to be important to both the farmer and the consumer during the next two decades.

Consumption of lamb and mutton, pork, eggs, and dairy products has declined recently, but consumption of poultry and beef has increased substantially (fig. 25). Preference for beef is expected to continue to increase (fig. 26).

The annual per capita consumption of pounds of selected meat by civilians for specified periods and expected in 1980 and 2000 is as follows: [9]

	Actually Consumed			*Projected*	
	1947–49	*1957–59*	*1963–65*	*1980*	*2000*
Beef and veal	75.3	89.2	102.9	130.0	135.0
Lamb and mutton	4.8	4.4	4.2	2.8	2.5

Veal declined from about 5 percent of total beef consumption in 1965 to about 3 percent in 1968, and it is expected to decline to about 2 percent by 1980 and to about 1 percent by the year 2000.

Per capita consumption of wool is expected to decline slightly, but total consumption will increase because of population growth, as shown in the following tabulation:

	1965	*1980*	*2000*
Wool consumption per capita, *pounds*	2.0	1.9	1.8
Total consumption of wool, *million lbs.*	387	447	554

The United States has substantial net imports of lamb and mutton, wool, and sheepskins. About 70 to 75 percent of our wool is imported, and we get up to 20 percent of our lamb and mutton from other countries. Thus, continuing preference for beef over lamb and mutton, and the impacts of imports, indicate further reduction of the domestic production of sheep.

Much of the increased demand for beef has been met by extending and intensifying operations in feedlots. In the 1950's, large numbers of cattle and some lambs went directly to slaughter from range or pastures. Now, fewer cattle are slaughtered as "grassfat," and an increasing share of meat production is from concentrates in feedlots (fig. 27).

The trend toward fattening beef in feedlots, coupled with a decline in dairy herds, has resulted in a relatively short domestic supply

[9] From unpublished data developed by the Natural Resources Economics Division, Economic Research Service, USDA.

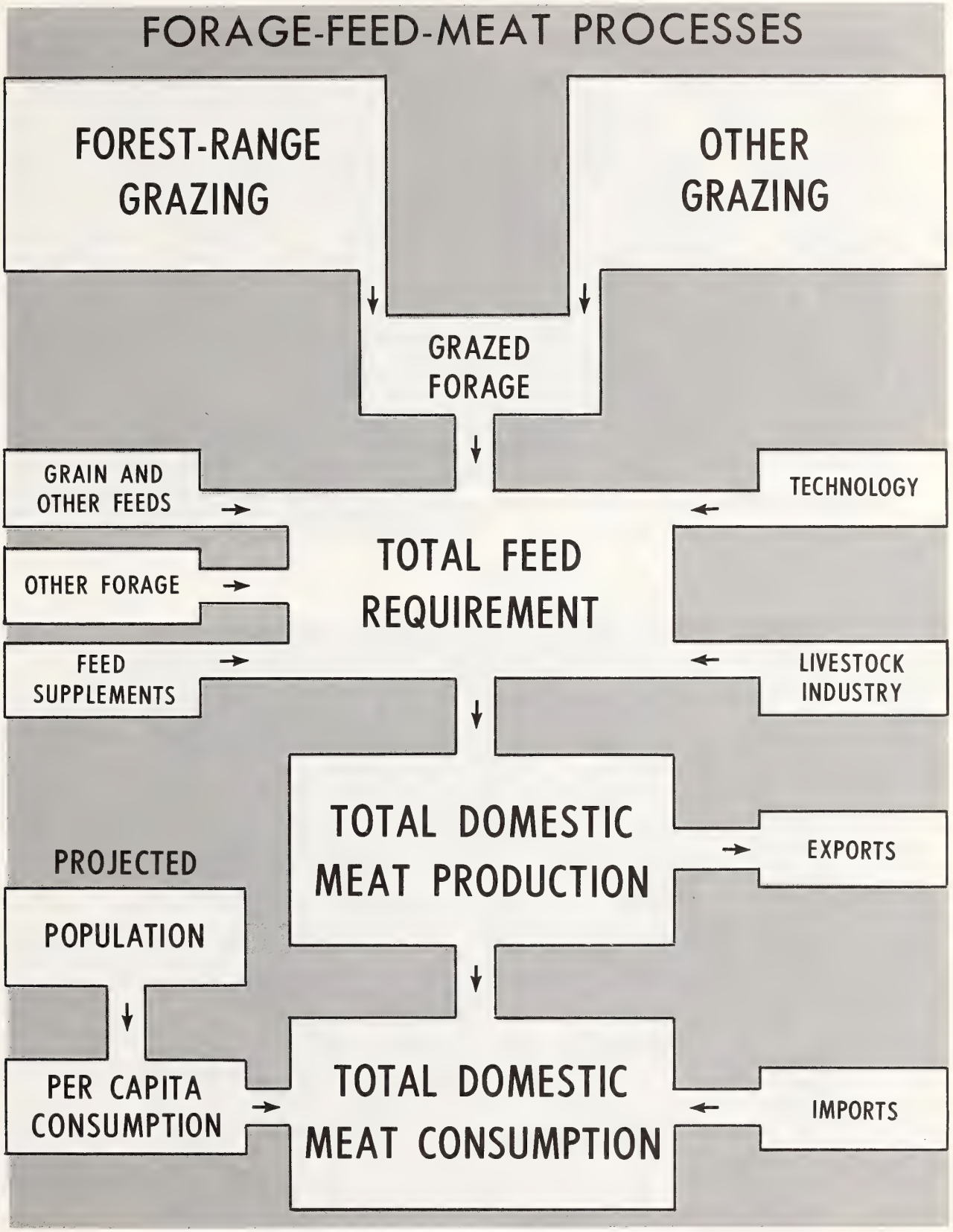

FIGURE 24.—Flow chart: Forage-feed-meat processes.

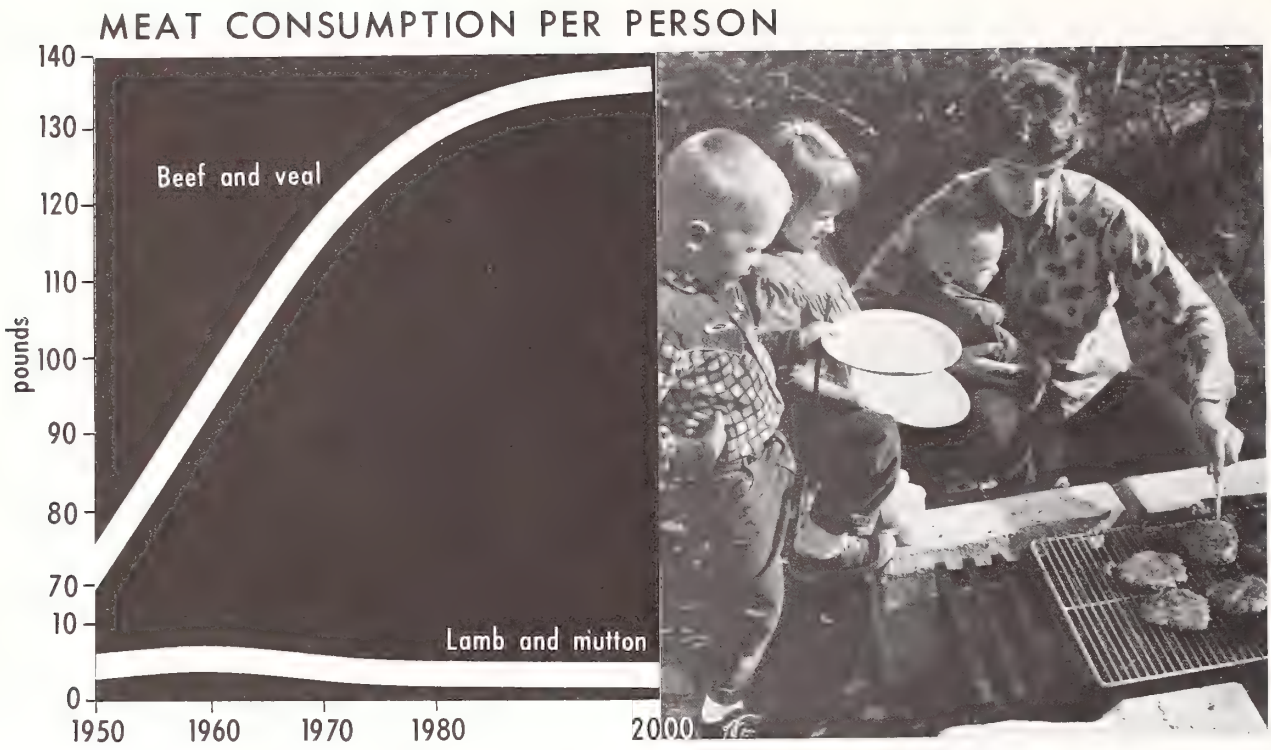

FIGURE 25.

FIGURE 26.—The Consumer has a preference for beef.

FIGURE 27.—Feedlots provide an increasing share of beef production.

of lean beef. Imports have made up the difference. Imports of beef approximated 9 percent of domestic production in 1968. On the other hand, exports commonly are less than 1 percent of domestic production.

American agriculture has the capacity to respond to the projected increased demands for meat and will respond if price relationships are favorable. This capacity to respond has been demonstrated: Between 1960 and 1968 beef production increased 41 percent. This increase, along with a doubling of beef imports, provided beef for an 11 percent increase in population and for the increasing preference by consumers for beef over other meats.

Expansion of the feeder cattle industry will lead to additional competition among rangelands, improved pastures, and croplands. More than 50 million acres of cropland, surplus to the Nation's needs for crops, is available and could be shifted into forage production (fig. 28).

USDA-Soil Conservation Service

FIGURE 28.—An abandoned and eroded cotton farm was converted to this high-yielding improved pasture.

In the face of the changing technology of beef production and apparent untapped productivity of pasture forage and other feed production sources, it might appear that forest-range may not be "needed" for livestock production. No doubt it is possible that other feeds and feed sources have the potential to provide the feed now supplied by grazing the forest-range. However, this study assumed a conservative viewpoint regarding such shifts. And the Nation could eat less meat; but this viewpoint, while possible for the United States, is not realistic.

There are other indicators that suggest continued high demand over the next 10 to 20 years for use of the Nation's range resources for forest-range livestock grazing. Historically, cattle and sheep have been the principal marketable outputs of forest-range ecosystems. The most consistent feature of the historic role of the forest-range has been its use as a low-cost feed source. Furthermore, many rural economies are substantially dependent on production of livestock from forest-range ecosystems. Increasing the production of range livestock may help strengthen these local or regional economies.

Forest-range lands can compete as they do now in providing the additional feeder cattle needed in the next 10 to 20 years if range costs do not increase relative to other feed sources. Competition among regions of the Nation will partly reflect availability of land and relative costs for raising feeder cattle. Forest-range will continue to support domestic production of lambs and wool.

Grazing Targets

The nature of the analyses used in the study required information on the demand for forest-range grazing that would make possible establishing "targets." Management within economic, social, and political constraints, and knowledge of the limitations of the environment itself to produce, are directed toward meeting these goals. The forest-range grazing targets, expressed in animal unit months of grazing, were derived from published and other information on common parameters as described here.

Expected domestic production of beef, veal, lamb, and mutton was derived by projecting population, multiplying by consumption per capita, and subtracting the projected level of imports. The probable demand for grazing can be estimated from the total domestic production required in 1980 and 2000. Because the lamb and sheep portion of the feed required and production expected is very small, the domestic production of lamb and sheep has been added to that of beef and veal. Thus, a single requirement for livestock was computed.

Projections of domestic production of livestock were used to estimate requirements for feed under these assumptions:

1. One and three-quarters pounds of beef must be grown to produce 1 pound of carcass weight.
2. Thirty-six of every 100 pounds of beef grown will be produced by feeding concentrates in feedlots in 1980 and 2000, as compared to 25 pounds in the period 1962 to 1966.
3. An additional 3.75 percent of liveweight production in 1980 and 3.50 percent in 2000 will be required for the expansion of beef breeding herds.
4. An increase of 7 percent in the conversion efficiency of feed will occur between 1970 and 2000.
5. In the production of beef, the share of feed supplied by grazing improved pastures, crop aftermath, and similar sources, and the share of grazing supplied by forest-range will remain fairly constant. This assumption of constant relationship between forest-range and all other sources of grazing is accepted as being suspect; but since reliable data were not available, no estimate of the changing relationship was attempted.

The results obtained in estimating the demand for forest-range grazing, when compared to other similar studies, appear reasonable. In summary, the projections were derived in the following manner:

> Projected population times projected per capita consumption of meat, plus other uses, results in total domestic consumption of beef and mutton. Per capital consumption was derived within a context of total food consumption including other meats, and as modified by changes in income and taste preferences.
>
> Total domestic consumption of beef and mutton was further modified by the consideration of beef and mutton imports and exports. Thus, a total domestic production of beef and mutton was estimated.
>
> Domestic production times the quantity of feed required per pound of meat produced indicated the total feed requirements and the particular mix of feeds included in these requirements. The total feed and feed mix was then modified by expected changes in the structure of beef industry, feed conversion efficiency, livestock breeding, production in feed lots, quality of feeds, knowledge of livestock diet needs, and production capabilities of various feeds.

The computed result is an indication of the total grazing requirement. The total grazing requirement was then divided between grazing of improved pastures and grazing of the forest-range environment.

These grazing requirements of the forest-range environment were used to compute an index. The index was applied to the production of animal unit months in 1970 as derived in Chapter II, Resource Situation—1970, in order to project production requirements for grazing in 1980 and 2000 from forest-range (fig. 29). In addition, a long-range target was estimated for the year 2020. The resulting levels for grazing from the forest-range environment were:

	1970	*1980*	*2000*	*2020*
Index	100	120	150	185
AUM's, *millions*	213	256	320	394

The AUM targets for 1980 and 2000 are not absolute requirements. They are reasonable levels given the limits of analysis, available knowledge, and stated estimates. Other things being equal, a basic consideration in selecting a policy alternative is that the cost per AUM should remain near current levels. Higher costs of forest-range grazing would result in substitution by resources and products, and it would be necessary, therefore, to establish new and lower demand levels that reflect this substitution.

Targets are specified for the total forest-range environment. Relationships among ownerships in the study are based upon competitive advantages to produce AUM's at least cost. Therefore, targets are not specified by land ownership. The same principles apply to regional targets. FRES procedures made it possible to select ecosystems and resource units for producing AUM's according to their comparative cost advantage.

There is no valid basis for estimating demand on a regional basis. Regions are not self-supplying. A single nationwide market is served competitively by all regions. The market system provides the interchange of supply and demand among regions. A set of regional output targets can be derived only by simultaneously considering national demand, regional supply potentials, costs of production and transportation, and projected market prices.

NONGRAZING VALUES

Although livestock grazing was emphasized, associated resources and their uses were also considered because these uses interact with livestock grazing over much of the forest-range environment. Extensive reliance was placed on the many studies of nongrazing outputs for projections of those needs.

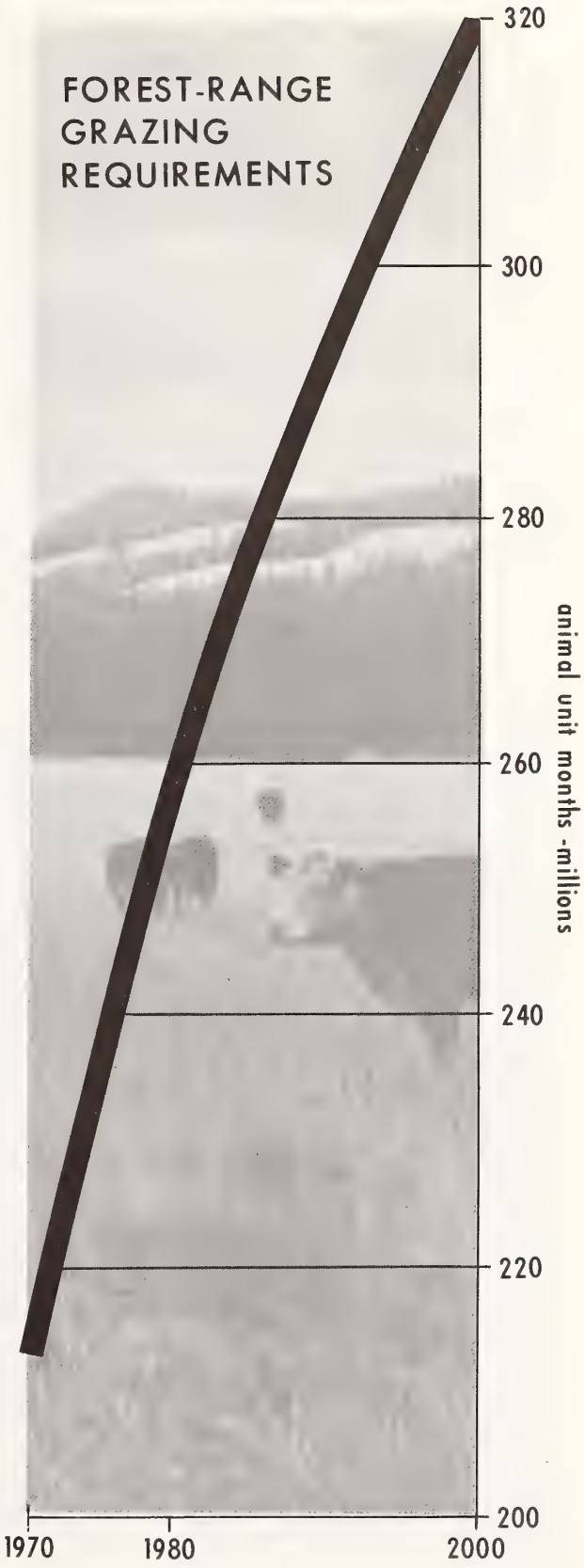

FIGURE 29.

Timber

A large number of price, demand, and supply studies have been made for timber. These studies indicate that an increasing consumption is expected for timber products. The projected increases in population, economic activity, and income indicate longrun-growth in activity in all of the major timber product markets. The endorsement by the President of the recommendations of the Cabinet Committee on Economic Policy and its Task Force on Softwood Lumber, and Plywood led to a goal for the Forest Service of increasing output of timber from National Forests and from non-federal lands.

Softwoods species account for 70 percent of the total timber products produced and used in the U.S. The expected increase in demand for softwood timber products was based on estimates of expanding uses. Expenditures for nonresidential construction are expected to increase from $40.3 billion in 1968 to $66.4 billion by 1980, and to $153.3 billion by year 2000. Residential construction is expected to increase from the 1968 level of 1.8 million units to 2.8 and 3.5 million units in 1980 and 2000, respectively. These construction estimates and the subsequent demand for softwood vary according to price levels.

The volume of softwood timber (round wood basis) required to meet the projected demands for softwood plywood, lumber, pulpwood, and miscellaneous products at three different price levels, is as follows:

Year:	Price levels		
	1962–67 average	1968	1968 prices plus 1% annual increase
	Billion board feet	*Billion board feet*	*Billion board feet*
1968	—	47.7	—
1980	67.5	55.0	49.9
2000	94.5	76.7	53.9

Projected total U.S. demand for hardwoods in billion board feet is as follows:

Year:	
1962	6.4
1968	7.2
1980	8.2
2000	10.2

Estimates of exports and imports show a net U.S. import of 5 to 10 billion board feet of softwood products per year (fig. 30).

Hardwoods make up about 30 percent of total U.S. timber consumption. This rate of consumption is expected to continue through year 2000. The projected consumption of hardwood timber will increase at a slower rate than that of the softwood timber types.

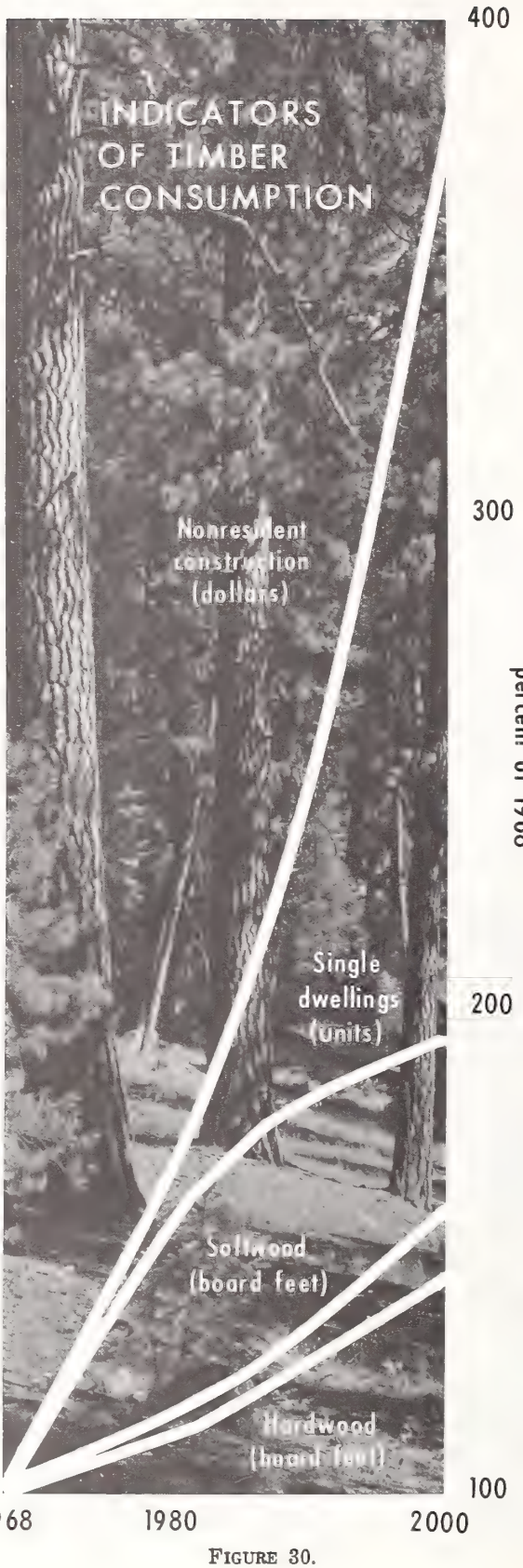

FIGURE 30.

All Regions in the Nation are expected to contribute to the supply of timber for the growing national market. The Western States have 27 percent of the Nation's commercial forests in terms of acreage, but produce approximately 72 percent of sawtimber volume, and have provided about 67 percent of the total annual softwood sawtimber harvested. The South and Southeastern United States have produced more timber products than any other part of the Nation in the past 100 years and show promise as future suppliers of timber. More than one-third of the Nation's commercial forest land and nearly 50 percent of the total timber growth is in the Southern and Southeastern States.

The Northeastern States produce primarily hardwoods. These States contain approximately 33 percent of the Nation's commercial forest acreage and 20 percent of the growing timber stock, and produce about 12 percent of the harvested sawtimber. The Plains States contain some timberland, largely in Oklahoma and Texas, the Black Hills of South Dakota, and along stream bottoms throughout the Great Plains areas.

Output targets were not developed on a regional basis. Timber is bought and sold in a national market system. To prepare regional output targets it would be necessary to relate national demand to regional supply capabilities, production and transportation costs, and anticipated prices of stumpage and finished products.

This analysis considers the production of wood growth at a constant intensity of management. This evaluation, therefore, does not permit considering fully the potential to vary timber growth and harvest through specific practices aimed at the forest resource. In addition, this study measures timber output in terms of growth rather than in terms of volume harvested. Thus, the range management strategy or combination of strategies that would produce wood growth at approximate current levels of national need, or that does not severely limit wood growth is regarded as satisfactory (fig. 31).

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FIGURE 31.—Cattle and timber production are compatible under proper management.

Water and Water Quality [10]

The forest-range environment is closely related to the Nation's supply of water. Many of the major streams in the United States originate in the mountain range lands and flow hundreds of miles to other forest-range ecosystems. Some of the regions are major suppliers of water, others contribute more sediment than others, and a few of the drainage areas are internal basin drainages. Some range-lands are high water yielding areas; others have the potential to yield more water through changed management or investment. Some ranges are sources of floods, and some are sources of silt that reduces water quality.

Great variations exist in precipitation, evapotranspiration, runoff, and streamflow among the regions of the country. These variations are further complicated by seasonal and annual variations and by precipitation, evapotranspiration, and runoff.

Water is in some ways a unique resource. It is not readily or cheaply distributed and it is not bought and sold in national markets. It may be either a final (consumer's) good or an intermediate (producer's) good. It may be used at or near the site of its production or at a great distance downstream. Furthermore, not all uses "consume" the water—hence, the projection of uses in terms of both "withdrawal" and "consumptive use." Because of its unique characteristics and the lack of national markets, "Water supply problems are often local, sometimes regional, but seldom national in scope." (Water Resources Council, 1968.)

Water as a product of rangeland may supplement or complement other uses or products of the land. Interproduct relationships that are supplementary or complementary should be fully exploited. Competitive conditions may exist and choices must be made. Where the relationship is competitive, a balance will have to be achieved—or a decision made on what parts of which range ecosystems are to be devoted primarily to management for water objectives. Some rangeland areas can and should be devoted to management designed primarily to yield additional water or to protect or improve water quality.

Not only are Americans concerned about having *enough* water in the future, they are also concerned about having "clean" water. Quality as well as quantity is a concern.

From the point of view of this analysis, the management level applied to range ecosystems can have explicit effects on both water quantity and water quality. Because of its uniqueness, however, the primary concern of water data in this analysis is on quality.

Sediment in stream channels is one of the quantitative measurements available in the current analysis. It is used as a measurement of water quality. Many of the forest-range ecosystems, particularly some members of the Western Range ecogroup, are major contributors of sediment to streams and stream channels. Minor decreases in the yield of water would be acceptable in some sections of the Great Plains and the Southeast, given higher supply relative to consumptive uses.

The Water Resources Council has estimated future water requirements on both a national and regional basis. Their projections have been based on explicit assumptions about greatly increased efficiency of water use, changes in technology, adjustments in price relationships, and potentials for substitution of other input factors—as well as increased population and economic activity. Their look ahead indicates that even with increased in-plant recycling, a large increase in reuse of water will be required. Investments in water development, water conditioning, waste treatment, and water management will be necessary.

On a national basis, withdrawals are expected to increase faster than consumptive use (fig. 32). Between 1965 and 2000 withdrawals will essentially triple, and they will almost double between 1965 and 1980. Consumptive use of water is expected to increase over the 1965 level by 1.23 times in 1980 and 1.65 times in 2000. In 1965 consumptive use was 29 percent of withdrawals; by the year 2000 it is expected to be 16 percent (table 8).

TABLE 8—*Withdrawals and consumptive use of water for the United States* [1]

(Millions of gallons daily)

Year	Withdrawals	Consumptive Use
1965 *(actual)*	269,617	77,782
1980 *(projected)*	442,626	104,418
2000 *(projected)*	804,610	128,206

[1] The Water Resources Council projections of water requirements are based on a higher level of assumed population growth (Bureau of Census Projection Series "B") than now seems likely. Data used for the general outlook of this report assumed population projection Series "D".

Needs for additional water will grow fastest in the Southeast and the Northeast. Relative importance of the regions will shift between 1965 and 2000. The West now makes the greatest share of all national withdrawals, but by the year 2000 the Northeast will withdraw more water than will the West. The predicted

[10] Unless otherwise noted the data and context used in this data on water are based on the report of the U.S. Water Resource Council titled "The Nation's Water Resources," Washington, D.C. 1968.

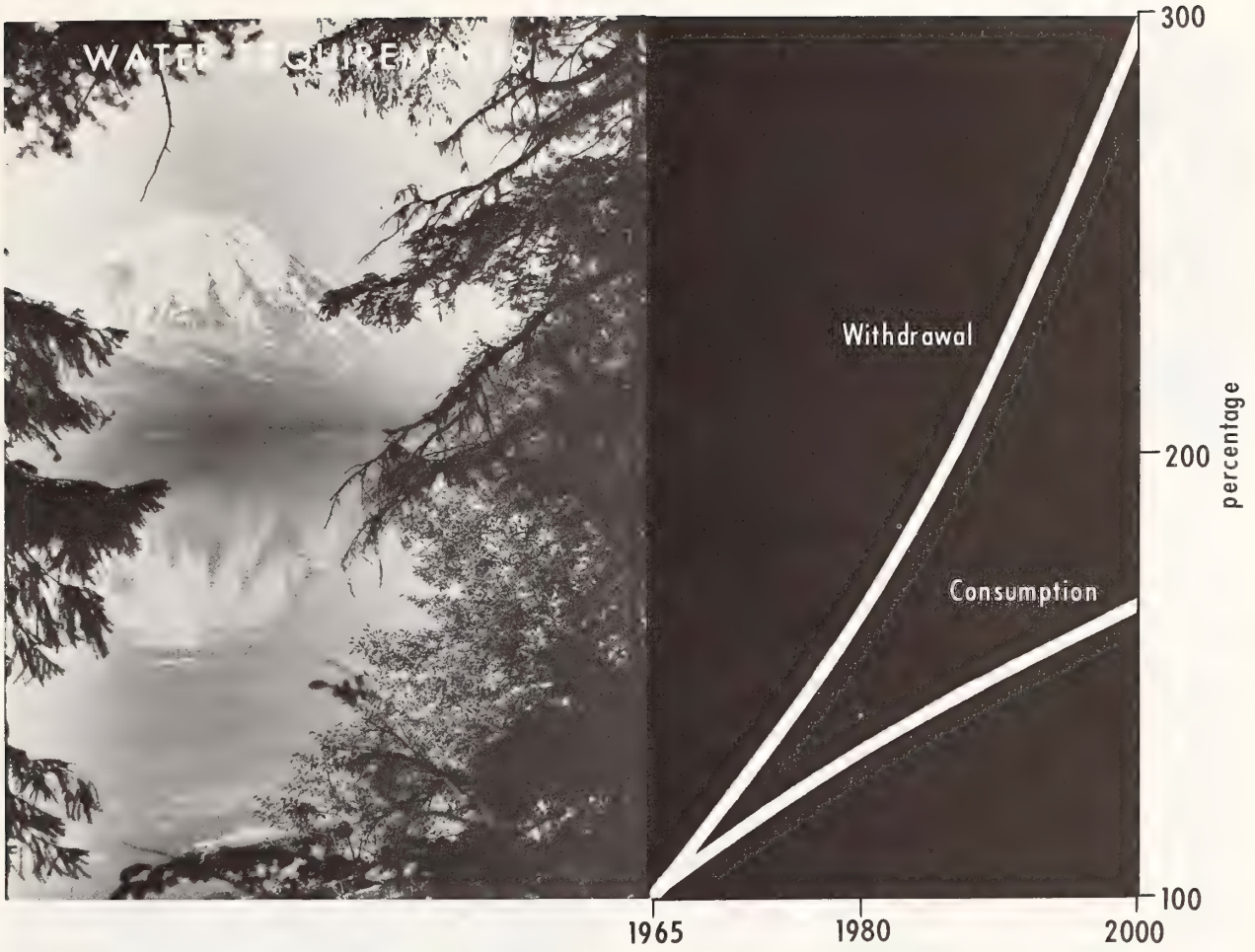

FIGURE 32.

low rank of the Plains may change. Expected energy production from fossil fuels in the Plains region would result in extensive water withdrawals.

Regional Rank—Water Withdrawals

1965	*2000*
1. West	1. Northeast
2. Northeast	2. West
3. Southeast	3. Southeast
4. Plains	4. Plains

Projected regional requirements for water are not strictly binding in terms of developing water supply programs. As indicated earlier, water may be used at points and in regions distant from its origin. For example, the major streams crossing the Plains to the Mississippi River originate in the West. Thus, range management programs in one region, such as the West, can have important effects outside the region.

In addition to uses that withdraw water from the streams, "use up" some, and return some, there are "in stream" uses. These include production of hydroelectric power, navigation, recreation, and production of fish and wildlife. Most suitable hydroelectric sites have been devoloped. However, it is expected that requirements for recreation, fish and wildlife, and navigation, as well as for energy, will increase.

In addition to all the needs for managing lands and waters already described is the need to reduce the frequency of and damage by flooding.

Qualitative Indexes of Demand

The Nation's forest-range environment is important to the quality of American life. Space is limited. Casual wasting and polluting, hardly noticed in the process of national growth, have become serious. Past abuses have caused segments of the environment, including forest-range ecosystems, to need repair and rehabilitation (fig. 33).

F—403271

FIGURE 33.—Severe gullying of this forest-range ecosystem resulted from improper grazing management.

Range management, as an art and a science, was developed initially in response to the needs of society to correct resource damage and to prevent further damage and losses. These needs for conservation and stewardship continue. More recently, however, society has become increasingly interested in forest-range as a part of the total environment. As a result, even higher demands may be placed upon the forest-range.

The qualitative outputs of the forest-range environment and their demands are discussed in very broad and general terms. In the subsequent analysis the values of these outputs are handled as changes in index numbers. Choices are simply between an improvement or deterioration of the base index. Generally, a practice is considered satisfactory when it does not cause the index values to decrease.

Recreation

Forest-range environment provides Americans with outdoor recreation. The general outlook is for growth of outdoor recreation activities. Open space and interesting and beautiful landscapes attract more and more people to forest-range. Demands for opportunities for camping and picnicking, hunting and fishing, hiking and rock hunting, and other outdoor recreation activities are all expanding. These increases in demands vary by type of activity and location (fig. 34).

Maintaining the quality of recreational opportunities and integrating recreation with other uses depend upon thorough understanding of range ecosystems. For example, livestock grazing, as one means for managing landscapes, can stimulate wildflower production or alter the herbaceous growth in and around recreational areas.

Most outdoor recreation is site-oriented. Outdoor recreation is not bought and sold in the open market to any great extent. It cannot be

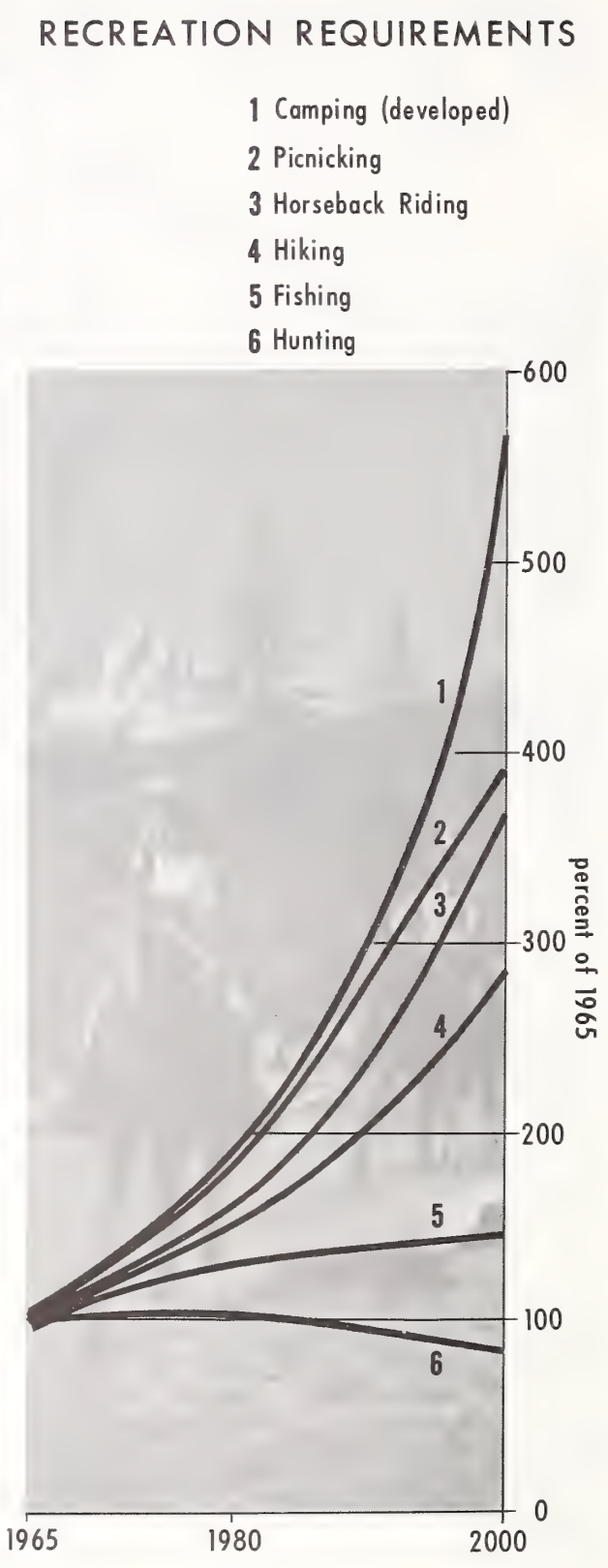

FIGURE 34.

transported to the consumer, and the greatest "needs" occur near the major centers of population. The major recreational activities on forest-range lands have little in common with those normally available nationally. The terrestrial ecosystems of forest-range for example, offer little opportunity for water-related activities such as boating, water-skiing, or swimming. Also, most of the forest-range is distant from the major population centers. The demand for the type of recreation available on forest-range varies by the nature of the recreation and the resources.

Wildlife

The Nation's forest-ranges are habitat for more than five million big-game animals and countless numbers of other animals (fig 35). Included are songbirds, upland game birds, reptiles, and waterfowl, as well as a myriad of lesser animals. Wildlife resources provide recreational opportunities and income for a broad spectrum of our population.

Important elements of the wildlife resource are those species which are rare and endangered. There is a high demand for the preservation of these species.

Manipulation of vegetation through such practices as timber harvesting, livestock grazing, type conversion, selective plant control, and introduction of new species can greatly influence habitat quality and, consequently, wildlife populations.

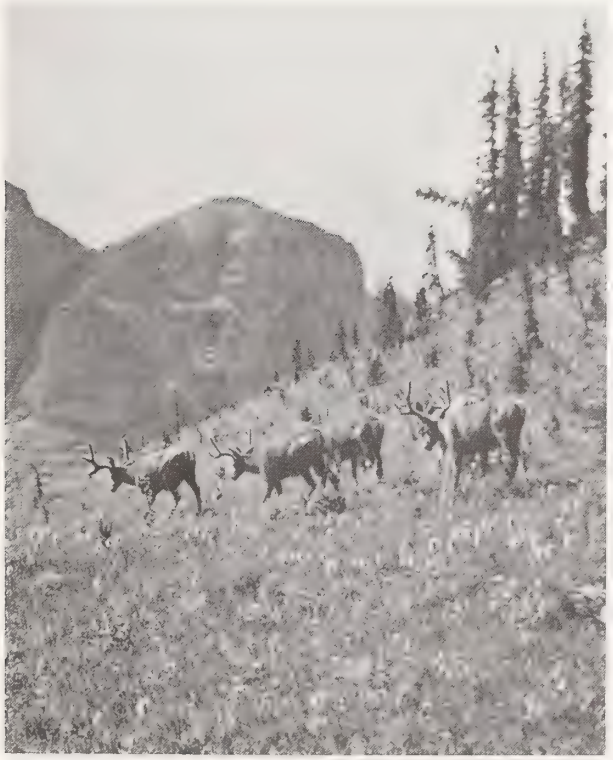

FIGURE 35.—Mule deer find suitable habitat on high-elevation forest-range (Photo by Danny On).

The needs for wildlife fluctuate with trends in hunting and fishing and with nonconsumptive uses of wildlife, such as bird watching or nature photography. Bird watching and nature photography, while generally not reported in wildlife-use statistics, constitute an important part of the use of the forest-range. They will become increasingly important in the future but will not account for a large percent of total use. Overall, the demand upon the forest-range for wildlife values is expected to increase.

Quality of Air

Physical properties of air—temperature, water density, and movement — affect the growth and development of plant and animal life. They limit man's use of the land. Chemical constituents—oxygen, carbon dioxide, and increasingly, pollutants—directly affect mankind.

Forest-range is a source of unpolluted air and has an immense capacity for receiving and disposing of pollutants from urban and industrial areas. However, range management practices can reduce air quality by increasing the amount of particulate matter. This commonly occurs when winds blow dust from areas cleared of vegetal cover or when range fires occur. The growing concern of the Nation over air pollution can only result in a growing demand for management of forest-range to improve air quality.

Soil Stability

Soil stability, which is simply keeping soil in place, helps preserve productivity and prevents downslope damage. Proper management of the vegetative cover is a paramount rule in maintaining soil stability. The impact of grazing animals under poor management, or of man in some high density recreation areas within a forest-range, often breaks the vegetation cover to set the stage for erosion with resultant lowered soil stability. Once the original level of soil stability is lowered, productivity is lowered. Sites may be so modified that original plant communities no longer can exist. Some of these may have had peculiar or intrinsic values that are irreplaceable once lost.

As an output from the forest-range, soil stability is an asset of national importance to be maintained in order to support our future growth and culture.

Soil Quality

Soil quality as used in this study relates to fertility, structure, and drainage. It is important to environmental quality in terms of maintaining or enhancing the productivity of a given site. It is closely related to soil stability and can, therefore, be materially affected by the level of management. Compaction of the soil or

poor fertilization practices can reduce herbage yield, affect the composition of the vegetation, and cause habitat and other changes that may influence small animal or bird populations. Thus, maintenance of soil quality is fundamental to proper functioning of forest-range ecosystems.

Beauty

Beauty is one characteristic of the environment receiving much attention today. Activities designed to use natural resources must be conducted in such a way as to avoid impairing the visual aesthetics of the area. Forest-range ecosystems have unique natural beauty. Management must be designed to protect and enhance these characteristics, and to prevent scarring the landscape in the process of achieving higher output.

Colorful rocks, unique geological formations, and a wide variety of plant communities provide an endless array of interesting scenery. Wildlife also is a source of beauty and interest.

Cattle, sheep, cowboys, sheepherders, rustic cabins, corrals, and sheep-camp wagons contribute to enjoyment of the forest-range landscape (fig. 36). The broad expanse of open space is another valuable attribute.

Cultural Heritage

Cultural heritage is a part of our environment seldom considered. Yet it is important. Ways of life such as ranching, or customs such as mushroom or huckleberry picking or pinyon-nut gathering, are as much a part of our cultural heritage as are birthplaces of famous personages or Civil War battlefields.

Some of the cultural values mentioned under Beauty also relate to cultural heritage as a forest-range environment output.

Other Values

Prior discussion dealt with values, both tangible and intangible. Many of these have separate and unique identities. Other values also have importance in the planning of resource

F—480175

FIGURE 36.—Pastoral scenes enrich the landscape.

allocation within the forest-range environment.

Employment and Depressed Areas

The Study endeavors to relate the outputs (primarily livestock production) to the associated employment of people. The identification of depressed areas is necessary in order to determine if the increase or decrease in employment is in areas known to have enduring unemployment. Increases or decreases of grazing output are related to areas where low income persists (fig. 37).

Flexibility

Flexibility in systems of managing forest-range ecosystems is important in the planning process, for it reflects the ability to change direction as new or better information becomes available. Since economic growth and planning are both dynamic and cyclic, decisions made in allocating resources must be flexible.

Long-term investment in high cost management or improvement systems usually reduces flexibility in use. A water impoundment for recreation purposes in a meadow mitigates against future use of a high forage-producing area for grazing.

SUMMARY

The quality of life, human life, depends on resources available, the manner in which those resources are used, and institutions of the people. The issue of concern in this study is the total environment of the forest-range resource and the satisfaction it can provide to people both now and in the future. If satisfaction is to be measured, it must be translated into terms useable in the planning process. Therefore, the demands by people for the various outputs of that forest-range environment must be assessed. When both current and future satisfaction is important, then it is necessary to project demands in order to ensure that current actions are so structured that future actions can fulfill wants.

The demands, current and projected, herein assessed provide essential information used in deciding how to use the forest-range environment, or how to modify that environment to provide satisfaction to the people. The assessment of demands in a systems analysis is designed to improve the quality of the translation of wants to specific outputs and to permit full consideration of demands in the decisionmaking processes.

Emphasis was placed on analysis of the demand for livestock grazing since it was the primary element analyzed in this study. Grazing demand also served as an example of the scope such analysis requires. Estimates of other demands on the environment were drawn primarily from other studies, and precise measurement was not attempted. In spite of the difference in treatment of each demand element, the importance of each as related to its impact on the forest-range environment is nearly equal. A complete study of all aspects of the demands for the forest-range environment outputs will be necessary before a complete basis for decision-making will be available for other uses of this environment.

Some conclusions about demands were made in spite of existing limitations. The demand for grazing will continue to increase, but at a slower rate than population and other variables. Similarly, the demand for nearly all of the outputs of the forest-range environment will increase, and each has its own pattern of growth and geographic distribution. The sum of all the demands puts an increased pressure on the resources and indicates the need to improve the understanding and the precision for applying management to the forest-range environment.

USDA photo

FIGURE 37.—A depressed rural area.

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Chapter IV

ANALYTICAL CONCEPTS AND PROCEDURES

This chapter is a discussion of the system of analysis utilized to answer questions relevant to policy decision-making. The discussion explains the analytical concepts and analytical tools and the process used in the Forest-Range Environmental Study to relate anticipated demands or changes in technology and the livestock industry to the future use of the forest-range environment. Policy alternatives and concepts are discussed as used to associate information on supply and demand to national or other goals within specified political, social or economic constraints.

The analytical system permits the simulation of different political, social, and economic constraints so as to show the effect of changes in these constraints on the use that should be made of different range resource units. Proper use is made of these "policy solutions" when they are considered as "advice" to local managers by showing the local manager his operation in the context of national or regional situations. Misuse is made of these "policy solutions" when they act as narrow restrictions on what the local manager can or cannot do. They should point the direction, not mark the route.

The basic assumption is that national range policy should be dynamic in which all relevant information is brought together for initial examination and periodic review. The study developed the necessary analytical tools to give the decisionmaker this planning option.

ANALYTICAL CONCEPTS

This study is based on the premise that efficiency is required in the allocation of resources. This premise originated from the recognition that the forest-range environment, which has long produced its share of national needs for livestock grazing, is in itself finite, and must be managed differently in the future in order to meet the higher levels of a greater variety of demands which society will place upon it. Management technologies will be needed for using the forest-range more efficiently for livestock grazing while allowing for the requirements of other resources and their uses. Efficiency in allocation of resources, as herein used, means that to the land is assigned the level of management or development, at a cost, that can reasonably be expected to bring about the total highest environmental, social, and economic benefit.

That efficiency in resource allocation is to be considered a reasonable, perhaps, urgent national goal is being brought to the fore in the decade of the 1970's. That maintenance or enhancement of environmental quality is a national goal already has been spelled out. The National Environmental Policy Act (P.L. 91–190) and Executive Order 11514 (35 FR. 4247) of March 4, 1970, require that all Federal agencies, to the fullest extent possible, direct their policies, plans, and programs so as to meet national environmental goals.

The Council on Environmental Quality associates "efficiency" with attainment of en-

vironmental quality goals in stating, "Decisions on attaining different levels of environmental quality need to take into account the benefits to be attained and the costs to be incurred. When the expected gains are large relative to the costs, it is clearly in our interest to move forward in cleaning up the environment. And such improvement should, of course, continue as long as the perceived added gains of attaining each higher level of environmental quality exceed the expected costs."

The use of least-cost criteria as a basis for decision-making is well documented in the economic literature. It is becoming more and more the basis for allocating Federal resources. The evaluation in this study is based on a carefully selected portion of the total costs. These are generally felt to be representative of crucial cost factors affecting geographic location of production. Efficiency of resource use is measured by these procedures.

The Council of Economic Advisers has established further validity to the premise that efficiency in resource allocation is a paramount public responsibility: ". . . measures to assure the efficient use of our resources and productive capability continue(d) to be an important feature of economic policy. Two conditions must be met if the performance of the U.S. economy is to match the rising demand placed upon it . . . productive resources must be employed efficiently in producing each goods or service, and economy should produce the combination of goods and services most preferred by society.

"In many sectors of the economy the discipline of the competitive market is enough by itself to ensure efficiency. In certain areas, however, resources may not be allocated efficiently without at least some Government intervention. The proper nature and degree of Government intervention in such sectors is always a central issue in economic policy. Changing circumstances means that Government must continually reexamine its role."

This statement by the "Council of Economic Advisers" is the essence of the purpose of the Forest-Range Environmental Study.

With the need of environmental quality spelled out by Congress and Government agencies and the assumption that attainment of environmental quality goals must consider efficiency, the direction for this study was established. One of the study's key goals became a search for the analytical technology that could be used in approaching the problem of higher efficiency in resource allocation.

Inasmuch as this study recognized the complexity of natural ecosystems and man's dependency upon them, it was necessary to select an analytical system that could approach the problem of dealing fully with as many of the ecosystem's components as would be feasible, and in such a manner that any part of the importance of each ecosystem component might influence a decision. Although a fully suitable analytical system for this high purpose does not exist, and perhaps never will, the analytical system used is as close to it as existing technology provides.

ANALYTICAL TOOLS

Knowledge of resources, resource capability, resource limitations, demands for numerous outputs, and the related investment costs in land are not meaningful in themselves. They need to be analyzed in a rational manner, and evaluated in relation to the needs of the public (fig. 38). This study sought ways in which many outputs, inputs, impacts, and trade-offs could be considered in a logical quantitative manner. An analysis was needed that could relate the output of commodities to demand and at the same time consider the output and demand for environmental quality.

While the study emphasized livestock grazing, it also considered associated resources and their uses because of their interaction with grazing on much of the forest-range. The study focused on management strategies geared to livestock production, and alternatives are provided only to change the supply of animal unit months produced.

A different concept is required when considering outputs other than grazing. The effects of the strategies, applied to the production of AUM's, were determined on non-grazing outputs. As the output of animal unit months is changed or constrained by applying these strategies, the effects on non-grazing outputs were recorded. Thus, this study determined whether a particular range management alternative had

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FIGURE 38.—Resource decisions may have far-reaching effects.

negative or positive effects on other outputs. Levels of range management were changed, while levels of managing other resources (timber, water, and environmental quality) remained unchanged. It was not a part of the Forest-Range Environmental Study to investigate the impacts of different management levels of timber, water, or environmental quality upon the environment.

THE FOREST-RANGE ENVIRONMENTAL PRODUCTION ANALYTICAL SYSTEM (FREPAS)

The Forest-Range Task Force and its working groups needed an analytical tool that would facilitate full and objective consideration of a complex mass of data on resource supply and demand as this relates to changing national policies and Federal agency objectives.

To provide the type of analysis needed for this study, an analytical tool known as the Forest-Range Environmental Production Analytical System (FREPAS) was developed.

This system allocates forest-range resources to the required production in terms of grazing and other outputs. By this allocation, the cost of meeting production requirements is minimized, and guidelines are provided by which resource managers can analyze the relative need and value of such future projects as revegetation, drainage, or fencing.

The analytical system was predicated on two basic ideas. First, the realization that resources, although substantial, are limited and, therefore, more consideration should be given to the setting of priorities for their use. Second, that the development of management and planning tools offers some promise for a rational establishment of priorities and subsequently effective action.

By including a number of quantitative factors, a system has been developed in which man is viewed as a part of the environment. The amount of investment in materials is to be kept as low as possible. Finally, the essential measure of success in this system is not production of consumptive items alone: it also includes achieving a quality environment—the production of non-consumptive resources. The system recognizes that production of food and fiber is necessary to the existence of mankind; but it also recognizes that mankind needs natural beauty, wildlife, and a stable environment. Immediate economic benefit or economic growth, thus, is not the primary objective criteria of this system.

FREPAS was developed by modifying the Generalized Agricultural Production Analytical System (GAPAS) which the Economic Research Service had completed in 1968 for determining food and fiber production objectives on private agricultural land. This system came to light during the search for an already-built analytical tool that could solve the production problems inherent in the forest-range.

GAPAS is based upon the theory of comparative advantage and employs the mathematics of linear programming. It mathematically computes a combination of cropping patterns and soil groups that will most efficiently meet the projected production goals specified.

In 1970 and 1971 Economic Research Service and the Forest Service cooperated in modifying the GAPAS model to meet forest-range needs. The result was the Forest-Range Environmental Production Analytical System. It utilizes the concept of joint physical products from a single land use and evaluates associated environmental values.

In the FREPAS system investment costs are minimized by using linear programming. This mathematical technique determines the optimum allocation of resources to obtain a particular objective. This concept permits the simultaneous consideration of both the productive capacity of the resources and the relative demand for the various products needed. By mathematically minimizing the costs of achieving an output level among resource-use choices, each acre is employed at its highest or best use with respect to that particular requirement.

The premise of cost efficiency is best used for long-run analysis because of the adjustment necessary for short-run, uneconomical, external, and internal situations. The system assumes current technical relationships because future production coefficients are unknown. And if an analysis that minimizes cost is to be useful, it must be assumed that resource managers will overcome inertia, lack of knowledge, and other restraints, and will move toward the most profitable adjustment.

The conventional linear programming model assumes a timeless, static environment and ignores the effects of a decision's impact on opportunities and choices during subsequent time periods. In an effort to reduce errors in conclusions derived from such a model, the FREPAS system externally controlled the shifts in production from the acreage existing in the 1970 situation.

The procedure is conceptually sound for specific uses of the model. The principal objective is to estimate, in the best and least biased manner possible, the future productive capacity of the several ecosystems. Use of this model assumes that the location of production will shift as production cost is reduced within clearly defined bounds, based on judgment and evo-

lutionary trends. To do otherwise would require the assumption that there is no motivating force to shift the location of production except random variation and change.

The Forest-Range Environmental Production Analytical System (FREPAS) consists of four basic parts: [11]

1. Forest-Range Land Inventory Production System. This is a series of computer programs for making data conversions, edits, and reports. This system accepts the input data from the field forms; prepares record tables of data; performs checks of validity of codes; compares data on the records with valid test ranges; prints out invalidated records; accepts change cards to replace, add to, or modify records; and prepares base record tapes of land inventory, production, and cost compatible with the input requirements of the matrix generator.

2. Input Generator. This program accepts various types of data and prepares an input tape which contains a matrix to be solved by a linear programming code. Since a linear programming code is used for solving many types of problems, the input and output are rigidly defined formats; therefore, the input generator must convert the input data into the required formats.

3. Mathematical Model — a classical linear programming technique that minimizes the costs of meeting specified output levels (subject to several types of restrictions and constraints). The linear programming code used is IBM's MPS/360 implemented on an IBM System 360, Model 65 Computer. This code is one of the most efficient and solves problems having up to 8,191 equations and an unlimited number of variables.

4. Report Generator System—a comprehensive set of programs which sorts and organizes output into several reports, including detailed and summary reports. Use of the Report Generator minimizes the time and effort required to read and interpret the results of the mathematical model.

REQUIREMENTS OF FREPAS

The analytical system, FREPAS, was designed not only to answer resource allocation questions in the efficiency sense, but also in the presence of political, social or economic constraints. It was designed to answer questions such as:

1. How can the many implications of changing demands, changing technologies, and changing policies be assessed?
2. What is the most efficient way for meeting future demands for forest-range grazing under existing public policies with respect to maintaining (1) a viable rural economy, and (2) a quality environment?
3. What is the existing capability of the forest-range environment to produce grazing and associated products?
4. What investment will be required to complete present policies?
5. What is the least-cost program of range management for achieving the required grazing production?
6. What is the least-cost program of range management for achieving selected levels of associated products?
7. What future patterns of production will prevail with additional range resource development?
8. Can range management improve such environmental attributes as rare and endangered species?
9. What are the costs and output implication of managing all of the forest-range environment under a single management strategy?
10. What is the impact of increases (or decreases) in demand for outputs of the forest-range environment?
11. Do the anticipated changes in demands and technology require new management policies?

RELATING DEMANDS AND POTENTIAL OUTPUTS

To investigate the impact of management and treatment options, it is necessary to analyze their relationship to the quantity, quality, and combination of outputs within as well as between various types of resources. The following discussion of definitions and general specifications is fundamental to an understanding of the analytical system (fig. 39).

The intent of the analysis and analytical tools described here was to relate the full complex of resource use, outputs, and costs, to a defined and logical segment of the possible demands for a specific output. The essential issue is planning for the rational use of resources.

In the past, range planning was conducted primarily to satisfy single resource production objectives with minimal consideration to associated resources. The single objectives could be satisfied because total demands for resource outputs were relatively low and the available land and water base (forest-range environment) was relatively large. It was both possible and practical to allocate efforts to single objectives. These direct approaches now are threatened by ever-expanding demands and a shrinking of available resources, plus an in-

[11] See inside front cover for reference to report that describes FREPAS in detail.

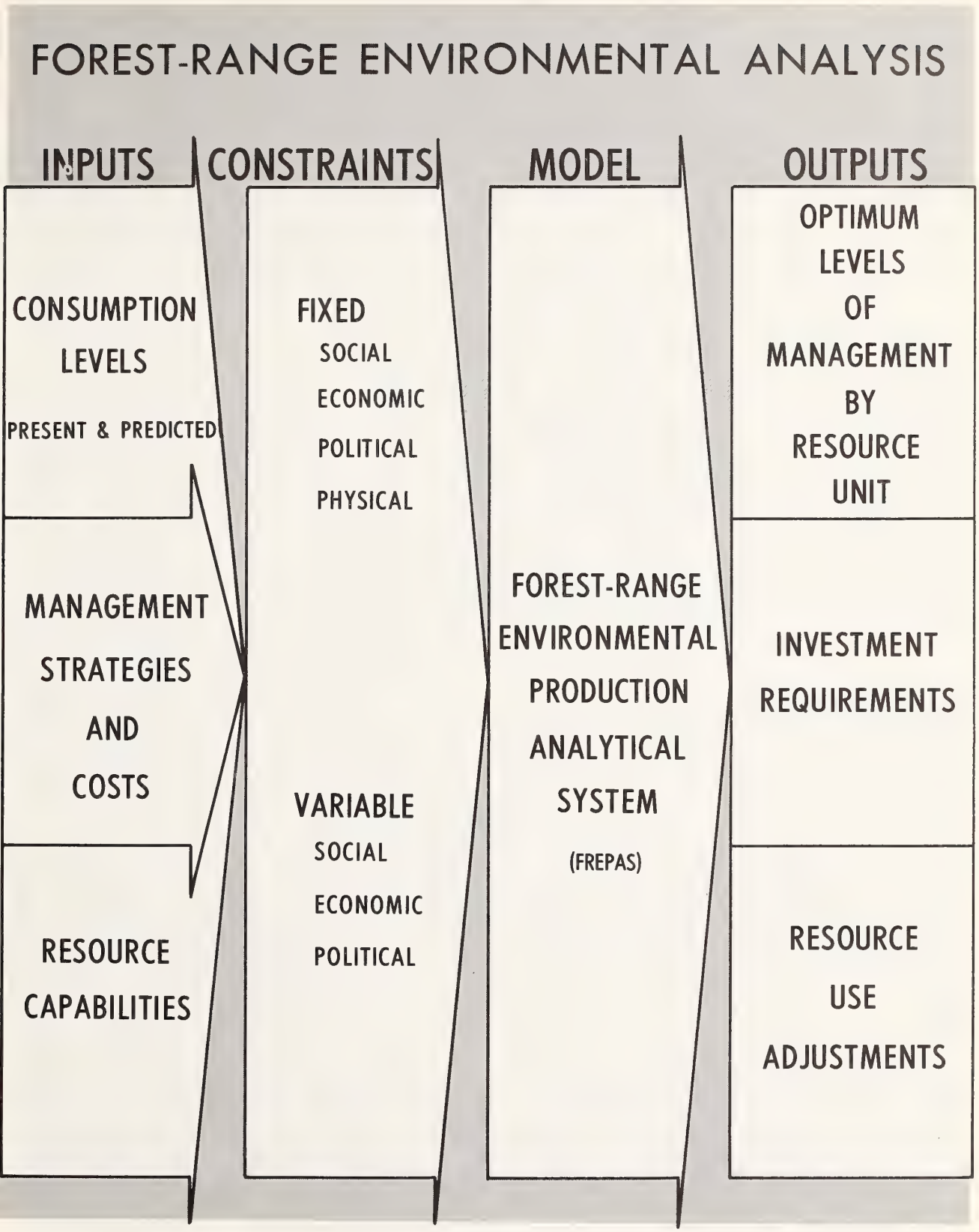
FOREST-RANGE ENVIRONMENTAL ANALYSIS
INPUTS
CONSTRAINTS
MODEL
OUTPUTS
CONSUMPTION LEVELS
PRESENT & PREDICTED
MANAGEMENT STRATEGIES AND COSTS
RESOURCE CAPABILITIES
FIXED
SOCIAL
ECONOMIC
POLITICAL
PHYSICAL
VARIABLE
SOCIAL
ECONOMIC
POLITICAL
FOREST-RANGE ENVIRONMENTAL PRODUCTION ANALYTICAL SYSTEM
(FREPAS)
OPTIMUM LEVELS OF MANAGEMENT BY RESOURCE UNIT
INVESTMENT REQUIREMENTS
RESOURCE USE ADJUSTMENTS

FIGURE 39.

creasing concern about how resources are used and how the environment is to be modified.

Therefore, objectives for use of individual resources are increasingly in conflict. It is now necessary to work with an intricate combination of resources within the total environment that must produce a complex of beneficial products.

In these analytical procedures a rationale is developed which visualizes the optimization of benefits as the goal while emphasizing the protection of the environment.

Optimization of resource use is casually and commonly recommended, but it is rarely attained nor are the means by which it can be attained fully tested in the real world. The system developed in this study and discussed here does not achieve optimization. It does provide a practical first step. The measure of demands is an integral part of such a system and represents the introduction of social values into the land management decision-making process. "In the past, having had so little understanding of what (our) options might be, most decisions have gone by default in this negative fashion. The great power of social data is to inform us as to what possibilities may exist." (National Goals Research Staff, 1970.)

New tools and techniques are needed that will make it easier to understand the complex of options. An analytical system capable of handling the large volume of relevant data and management alternatives must include the consideration of environmental quality and social values as future outputs of the forest-range resource. This report and system is a response to such need.

This concept suggests that because of resource substitution, analysis must be in terms of demand for goods and services from rangelands as one of several alternatives available for satisfying the total of social wants (fig. 40).

USE OF PROJECTED DEMANDS

Projections of demand enable planners to understand the magnitude, direction, and consequences of future trends in the production of commodities. In this study these projections relate such demands to forest-range outputs. Reasonable values are assigned to targets for a particular purpose. Statements of what will be or must be produced are avoided. Future markets are estimated using given assumptions along with extrapolations from historical data. Within the constraints of national need, the Forest-Range Environmental Study has estimated the livestock grazing in each of the forest-range ecosystems. The comparative advantage offered by each resource unit provides the basis for the study.

Two cautions are essential: (1) the projected output cannot exceed the grazing potential of the forest-range, and (2) the assumption that forest-range will maintain a constant share of the Nation's output of animal unit months from grazing needs to be examined critically. Since the projected increase in meat requirements may be met in several ways, economic forces will determine how and where the new production will take place.

Complete analysis of a recommended action requires the study, development and description of appropriate alternatives for which unresolved conflicts exist. Alternative actions must be studied and evaluated in order to avoid some or all of the adverse environmental effects. Sufficient analysis of such alternatives, their costs, and their impact on the environment should accompany a proposed action while decisions are being made in order not to overlook options that may be less detrimental.

Costs were a factor in the planning process, and included range management costs and associated direct management and maintenance costs. These expenditures are investments in the land itself. Other costs associated with production were not included in the analysis except as external variables reflected in the institutional constraints.

An implicit assumption of using only investment costs is that the production costs directly associated with livestock management, when compared and averaged among the ecosystems will not be significantly different. Basically, this is a reasonable assumption in the long run. The analysis, therefore, keys on the cost of using a grazing resource that has a wide and diverse set of physical characteristics. This is reflected in the major differences in rainfall and temperature.

The study objectives to which this methodology is applied are described as (1) a general appraisal of the forest-range resource of the United States and (2) the development of potentials. In economic terms, the objective is to analyze the allocation of resources to alternative and competitive uses while maximizing the utility of resources to achieve specific output levels. The resources of principal concern are land and water as they relate to the efficient fulfillment of production requirements, consistent with national policies and goals for food and fiber. The effects of assumptions and the output levels need to be continually reconsidered.

Clearly, economics is important in the effort to attain a high quality environment. Intelligent economic decisions and the wise allocation of resources are essential to achieving environmental goals. While pure dollar efficiency of investment is not an end in itself, the capital available can be a limiting factor. Therefore, efficient allocation of investment makes it possible to more effectively manage additional

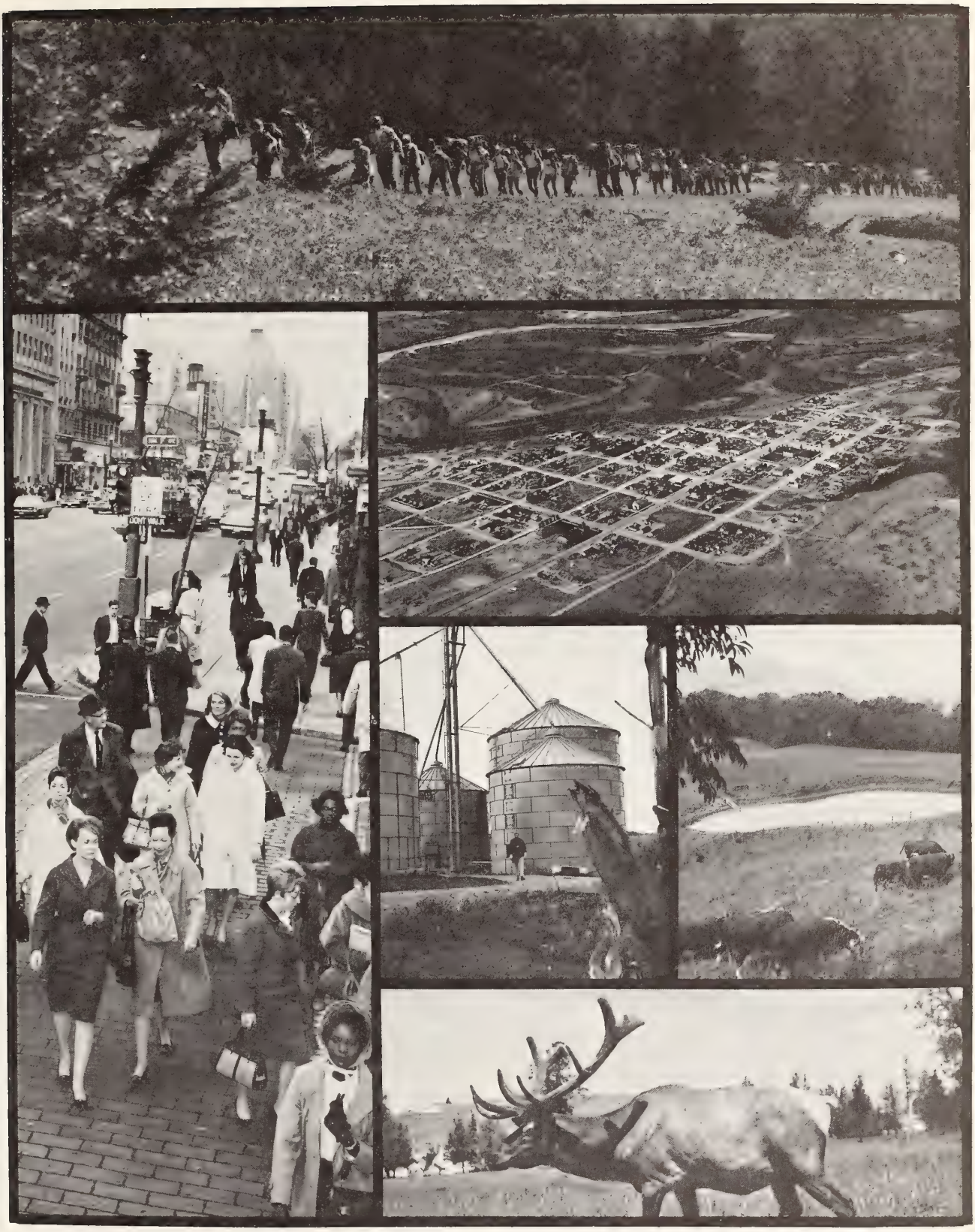

FIGURE 40.—Land can have many uses, depending on its location, its characteristics, and man's needs.

increments for achieving environmental quality.

The analysis has some specific values for the Forest Service, for example, as one segment of the managers (owners) of the forest-range. It can help establish policies that will provide fair competition among users and nonusers of the National Forest System for grazing. Therefore, this report defines the use of the forest-range by various ownerships on the basis of comparative advantage of the forest-range environment. The actual productivity of the land itself and the cost of developing it are the determining factors. It is not necessary to assume a level of use of Forest Service-administered public land since the level of use is a specific outcome of the analysis; this level is also the share of the animal production, largely beef, that will be assigned to the National Forest System.

ANALYTICAL PROCESS

All of the land inventory information on the forest-range resource base, including estimated outputs under varying levels of management and investment costs for attaining specified outputs, was used in testing the validity of policy alternatives towards meeting specific objectives. Each set of policy alternatives was structured with its own set of constraints; most of these were associated with levels of production of animal unit months of livestock grazing set through the demand analyses described in Chapter III, Demand for Outputs of the Forest-Range Environment. Some policy alternatives were simply projections of the future situation, assuming all or part of the potential productivity of the forest-range resources was utilized under a particular set of directions.

As will be shown in Chapter V, Analysis of Alternative Mixtures of Resource Use, development of the analysis was, in fact, a learning process. Direction was obtained from the relatively simple initial analyses for the development of further analyses. While these analyses became more complex, they in fact homed in on the desired outputs while meeting the specified social, political, or economic constraints.

The alternatives tested are designed to evaluate policies for management of the forest-range resource.

Ideally, the best policies are those that provide the needed increased grazing while permitting increases in wood growth, improving the water quality, and in some areas increasing water yield. In addition, the indexes of qualitative outputs also tend to increase. At the same time, the analysis must recognize that change itself has a cost.

The Government's role is especially important in the management of the forest-range. Thirty-two percent of the grazed forest-range acreage is administered by Federal agencies, and 14 percent of the grazing is from these lands. Actions by the Government, therefore, have major impact on the efficient use of resources and on the mix of outputs derived from those resources. The study assesses the national demand for outputs from the forest-range and breaks down these outputs into those that come directly from the forest-range. All of the evaluation of the resource is in a context of efficiency by the resource ownerships.

Two basic types of analyses were undertaken. These are: (1) constant and single strategy management, and (2) mixed strategies.

In the first phases of the analysis, the conceptually simple technique of single and constant management was used. This made it possible to estimate certain situations within a two-dimensional context, i.e., demand and supply. This two-dimensional analysis indicated the consequences, including the cost of using single strategies across all resource units. This helped set the study boundaries, an invaluable help in later interpretation.

When investment costs are included as inputs rather than outputs in the least cost analysis, the problem of evaluation becomes more complex. Investment costs can be increased or decreased, depending on the combination or mix of the management strategies. Given the current demand for both commodity and environmental quality outputs from the forest-range, there was an additional need to develop an analytical tool capable of measuring the trade-offs between commodity outputs and environmental outputs while simultaneously considering the impact on investment costs.

As previously described, this system incorporated as many product values as possible in the attempt to describe and analyze the broad spectrum of goods and services obtainable from forest-range resources. The specific outputs varied greatly in form, value, measurement technique, and in the relationship to output from the various analytical techniques. This heterogeneity is not conducive to simple specifications for achieving the desired output mix, but is helpful in providing comprehensive considerations of policy alternatives.

The nature of the mathematical technique employed (linear programming) is such, however, that specific national demands must be translated into discrete output value or values in order to obtain a solution.

For this reason, grazing output (whether herbage, animal unit months, or animal output value) becomes the baseline for the operation of the model. Only in this way can investment costs of improved grazing practices be optimized against a consistent constraint. Interaction of the baseline output with other outputs is studied as succeedingly more complex and stringent demands are placed upon the re-

sources. With each solution that came from the system, qualitative estimates of amenities were computed to evaluate changes in environmental quality. While these environmental values have little meaning in an absolute sense, they provide measures of changes in the environment that are associated with alternative levels of range output.

Hence, outputs as specified for use in the system are not fixed or finite, but are rather a series of estimates of output values for grazing alone; or they are constrained by other product values to simulate alternative management policies as specified by the user of the system. One test with one answer would have little, if any, value. The real value of the model is the analysis of change which results from alternate levels of output. In this sense the solutions are used as learning devices to help sharpen human policy judgment rather than to serve as answers in themselves.

Operational Techniques

Each alternative solution showed how forest-range resources should be allocated at least cost to produce a specified quantity of animal unit months of grazing. Different alternatives were constructed in order to identify resource units most likely to participate in future forest-range production. Each alternative specified the size of the animal-unit-month output, and several restricted the magnitude of shifts allowed in area grazed, as well as the rate of investment and disinvestment permitted in range management.

Basic data was translated to relate to a particular set of issues in order to determine how various policy alternatives compared in reaching objectives. A series of alternatives was tested and each alternative was built on the information developed from the last one. In this way knowledge was acquired as to how the system operates with respect to issues (fig. 41).

This preparation permitted discussion of policy alternatives for the production of animal unit months from a national point of view. The resource class by management strategy mix associated with alternative policies, together with physical and dollar costs and resource outputs was evaluated for impacts of policies.

To handle biological and other constraints against the application of management strategies, two base limits were established. "Maximum" was used to indicate the best estimate of the greatest proportion of a resource unit to which a given management strategy could be applied, considering biological and physical capabilities of the site. To handle non-biological and non-physical constraints, another baseline was used. "Minimum" indicated the best estimate of the least amount of land in a resource unit that could be managed under a given management strategy when considering laws, institutions, or policy commitments.

Each of the alternatives considered was constrained by the amount of land resource available and by the level of the target in animal unit months specified for that alternative. In addition, other biological or institutional constraints were applied to each alternative at the ecosystem and/or resource unit level.

The intent of these specific constraints was:

1. To eliminate use of a management strategy from an ecosystem when it is unacceptable because of biological limits, law, or long-term policies.
2. To eliminate use of a management strategy from an ecosystem because of known social or economic factors but which are not included elsewhere in the analysis.
3. To eliminate use of a management strategy in an ecosystem when such management seriously deteriorates the qualitative variables.
4. To permit a reflection of time as a factor in the amount of change between production areas or between management strategies.
5. To require the use of an ecosystem or management strategy because of biological or political limitations.
6. To impose a given set of conditions and thus permit analysis of the effect of that set of conditions on the residual.

The data were not tested for sensitivity and the impacts on each of the resource units were not examined. The absence of such testing and knowledge of detail limits the interpretation of the analysis. The analytical viewpoint is limited to broad objectives of policy from a national viewpoint.

Operational Assumptions

1. Production of animal unit months from the 1.2 billion-acre forest-range environment will be 256 million in 1980, 320 million in 2000, and 394 million in 2020.

2. Economic forces are primary determinants of location of additional forage production. Difference in investment cost per animal unit month is a valid measure of the probability of a given ecosystem being used in a particular manner.

3. Use of Strategy E (management for maximizing livestock production) is not compatible with the legal obligation of the Federal agencies to establish multiple-use management and is not considered as an option on Federal lands.

4. There are practical limits as to how much forest land can be cleared annually, and the value of timber production from these lands is not fully recognized in the analysis. Therefore,

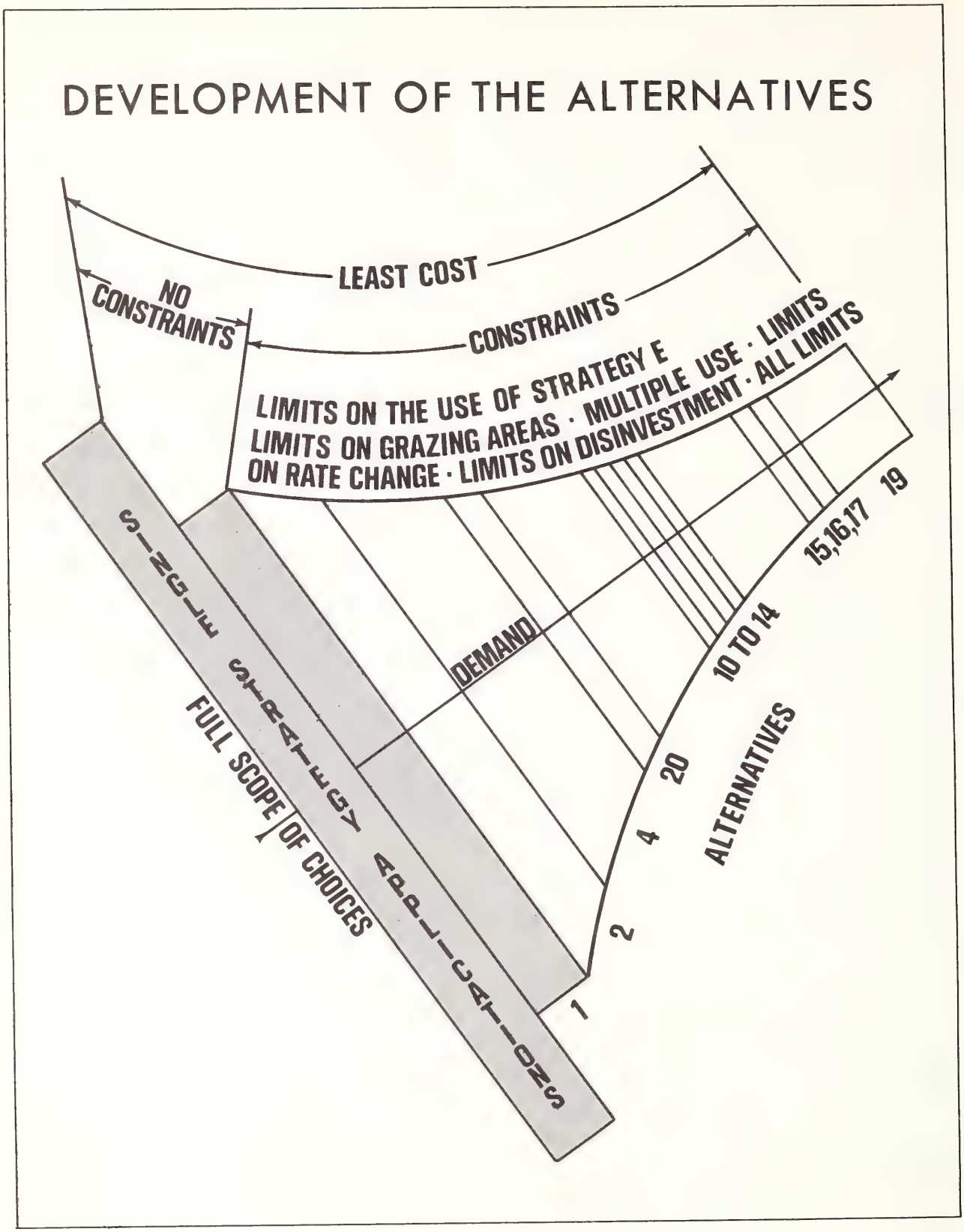
DEVELOPMENT OF THE ALTERNATIVES
LEAST COST
NO CONSTRAINTS
CONSTRAINTS
LIMITS ON THE USE OF STRATEGY E
LIMITS ON GRAZING AREAS · MULTIPLE USE · LIMITS
ON RATE CHANGE · LIMITS ON DISINVESTMENT · ALL LIMITS
DEMAND
1
2
4
20
10 TO 14
15,16,17
19
ALTERNATIVES
FULL SCOPE OF CHOICES

FIGURE 41.

constraints are placed on the rate at which Strategy E can be applied to non-Federal forest ecosystems.

5. The trend in the location of future grazing will be significantly indicated by the costs of grazing among ecosystems.

6. Strategy X (exploitative management) is not acceptable and was arbitrarily excluded from further consideration as a management option.

7. The changing intensity of management requires the relocation of investment. The rate at which investment shifts can occur is limited.

SUMMARY

The Nation has set out to maintain a high standard of living that includes both quantity and quality of economic and social goods. Rational planning and analysis requires a systematic set of concepts and procedures, selected on the basis of the objectives to be satisfied. The maintenance of standards, both now and the future, requires planning of resource use in an efficient manner because the basic resources are limited. Projected demands must be related to the resources available in order to determine the mix of inputs required to achieve the desired mix of outputs.

Analytical procedures and analytical tools were developed for use in this task. These procedures include the assessment of demands, the measurement of the productive capacity of the resource, and the trade-offs between outputs. The analytical tools include accounting systems to handle the mass of resource and cost data, and a linear programming code capable of accepting a variety of externally derived constraints.

The use of these concepts and tools plus the addition of carefully structured program alternatives provides an operational system of analysis. In the following chapter the analytical system is applied to the demands, costs, capacities, and constraints related to the forest-range environment.

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Chapter V

ANALYSIS OF ALTERNATIVE MIXTURES OF RESOURCE USE

This chapter presents selected policy alternatives constructed from the technology and information discussed earlier. The alternatives tested are defined and discussed and the utility of FRES and FREPAS is shown. Information on the resource base and its estimated responses to changes in management is associated with the information on costs and demands, and is applied within needed environmental, political, social, and economic constraints so as to meet policy requirements. Each alternative selected for evaluation was measured against broad policy objectives of the Federal Government.

A series of alternatives was tested, and each alternative was built on the information developed by the previous one. In this way knowledge was acquired as to how the system operated with respect to the critical issues.

This analysis could have been reported on the basis of impacts and changes occurring by ecosystem, ecogroup, State, geographic area, Forest Service administrative region or nationally, separately or in combination. However, the quantity of data generated would have been massive and would not have significantly increased understanding of the system. Detail was omitted, therefore, but throughout this Chapter some observations and individual items of data are included to illustrate the full range and depth of analysis possible.

The alternatives are measured against the projected demands, the existing resource situation, the changes in investment costs, and changes in efficiency of investment.

DATA USED AS BASE POINT

The resource situation existing in 1970 was used as the base for evaluating all alternatives. The basic function of this 1970 resource inventory in evaluating alternatives was the assignment of current management strategies to each resource unit and the estimation of the production of outputs. The Resource Situation–1970 was the best estimate of the proportion of land that was being managed under each strategy in 1970. Now Policy was the second base point and was an estimate of the proportion of area planned (as of 1970) to be subjected to each of the six management strategies by year 2000.

The Resource Situation–1970 and the Now Policy represent evaluation points to which the alternatives can be compared. The impact of an alternative, therefore, was measured in terms of change from these benchmarks. The Resource Situation–1970 was also used as the basis for establishing the constraints. Limitations on changes are computed from the acreages that existed in 1970.

DESCRIPTION OF SELECTED ALTERNATIVES

The alternatives tested were designed to provide a general understanding of the forest-range situation and the functioning of the analytical system. These alternatives were de-

veloped as logical and reasonable approaches that might help resolve critical policy questions in range resource management. In addition, some alternatives were designed for the primary purpose (as part of the learning process) of providing measurement points for interpretation of subsequent alternatives. Each alternative has an output and a set of specified limits. In each case the investment cost is the minimum necessary to achieve the output levels specified.

Elements of the alternatives to be discussed are presented in the following:

Identification	Required output level (*Million AUM's*)
Inventories:	
Resource Situation—1970	213
Conditions: An inventory of the situation in 1970 as developed within FRES definitions.	
Now Policy	462
A compilation of the existing 1970 plans for development to year 2000 as estimated by field professionals.	
Single strategy applications:	
Strategy A—No livestock	0
Strategy B—Some livestock	184
Strategy C—Extensive management	317
Strategy D—Intensive management	566
Strategy E—Maximize livestock	1,739
Strategy X—Exploitative management	None
In each case the single management strategy A, B, C, D, or E was applied to all lands of the forest-range environment, limited only by the biological maximums and institutional minimums. (Strategy X was not developed as an alternative because it is not a rational management goal.)	
Efficiency applications:	
Least cost (unconstrained):	
Alternative 1	223
A national alternative under a minimum cost criterion without imposing additional constraints except for the biological maximums and institutional minimums.	
Alternative 20	320
This alternative was identical in structure and constraints to Alternative 1 with the AUM requirement equal to the AUM output of year 2000.	
Alternative 2	462
A national alternative to achieve an AUM output equal to the "Now Policy" AUM output under a minimum cost criterion without imposing additional constraints.	
Least cost (constrained):	
Alternative 4	222
A national alternative to achieve AUM output under a minimum cost criterion after *imposing constraints* on selected ecosystems. These ecosystems with high AUM production potential were constrained against significant AUM production increases.	
Alternative 10	223
Alternative 11	267
Alternative 12	334
Alternative 13	412
Alternative 14	461
National alternatives 10 through 14 were to achieve AUM targets, current and projected, under the same set of constraints for each target. The *constraints* continued those of Alternative number 4 and, in addition, required that all lands grazed in Resource Situation—1970 must remain in grazing. Acres grazed could increase but not decrease.	
Alternative 15	267
Alternative 16	334
Alternative 17	412
National alternatives 15 through 17 were to achieve projected AUM targets under the minimum cost criterion with a set of special *constraints*. These constraints include the limits of Alternative number 4 on eastern ecosystems and *prohibit* selected changes in the intensity of management. These constraints are eased, as a reflection of time, between 15 and 16, and between 16 and 17.	
Alternative 19	320
This national alternative for year 2000 represents an accumulation of the knowledge and constraints acquired in evalution of previous alternatives. The constraints require a specified output of wood, herbage, water yield, quality water yield, and sediment. These levels were established as equal to or greater than the output levels in the Resource Situation—1970. Changes in grazing were further limited to a 2 percent per year change in the acreage of each management strategy on each resource unit from the acreage on that resource unit in 1970. Strategy E (maximize livestock production) is prohibited on all Federal lands and on all non-Federal lands in forest ecosystems. All resource units not having grazing in 1970 were limited in year 2000 to an increase in grazing to 10 percent of total acreage in that resource unit.	

Area grazed, total investment costs, costs per animal unit month and all outputs for the Resource Situation–1970, and all alternatives are shown in table 58. Selected information is presented in text tables and figures accompanying discussion of the alternatives.

NOW POLICY AND SINGLE STRATEGY APPLICATIONS

The Now Policy alternative was constructed from a series of estimates of management direction as of 1970. These estimates were made by personnel acquainted with practices of the Forest Service and other "owners." The distributions of management intensities used in formulating the Now Policy were estimated at the time the inventory was compiled. They represent the judgment of the personnel par-

ticipating in this study as to the actual direction land managers were heading under existing policies. In a sense, the Now Policy alternative represents the conventional wisdom of specialists in forest-range management and research.

The animal unit months and acres grazed resulting from this particular combination of strategies are shown in table 9. Of special interest is the level of AUM outputs. The 462 million AUM's produced are greater than the projected grazing requirement for year 2000 (fig. 42). This does not reflect mismanagement or over-investment from a local viewpoint; it may reflect misallocation and over-investment from a national viewpoint. The potential of the forest-range to produce AUM's as indicated by this alternative is more than twice that produced in 1970.

TABLE 9.—*Area grazed, selected outputs and costs for Resource Situation–1970 and Now Policy.*

Item	Units	Resource Situation-1970	Now Policy [1]
Area grazed	Million acres	834.9	852.0
AUMs	Million	213.1	461.5
Wood growth	Billion cubic feet	20.5	18.9
Water yield	Million acre feet	780.1	773.8
Quality water	Million acre feet	706.3	697.5
Sediment	Million tons	1,658.3	1,489.6
Total investment cost	Million dollars	858.2	1,960.4
Cost per AUM	Dollars	4.03	4.25

[1] Now Policy represents the predicted situation in the year 2000 under 1970 policies.

Under this alternative 852 million acres would be grazed as compared to the 1970 acreage of 835 million acres. A reduction in wood growth would result and a significant but

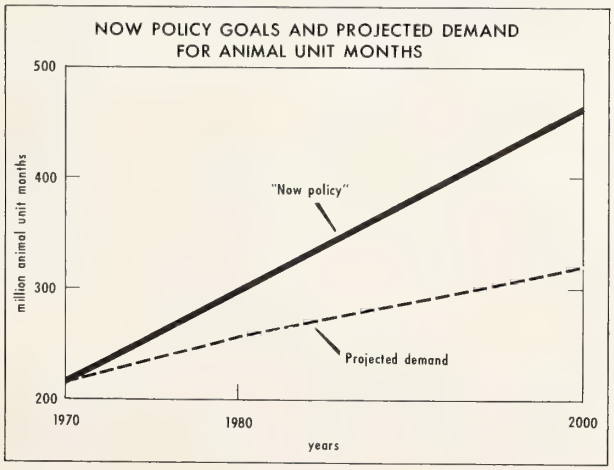

FIGURE 42.

favorable decrease in sediment would occur. Water yield and quality water would not be materially affected. While total annual investment costs would increase to $1,960 million, cost per AUM would increase only 5 percent over the 1970 cost of $4.03.

It is possible to analyze single strategy applications of management from available information. The total land available for grazing was allocated entirely to each of the management strategies, except for the standard resource constraints. It was not intended that these alternatives represent a realistic possibility, but rather that they would measure in a general way the grazing potential and the impact on costs, including environmental quality.

The first single management strategy tested was Strategy A, no grazing on the forest-range environment. A no-grazing policy would mean that production from the 835 million acres grazed in 1970 would be replaced by other grazing sources and by other production processes applied to the source, or by additional grazing on improved and irrigated pastures on cropland (table 10).

The results of no grazing on the forest-range environment would include the following benefits:

a. Herbage now used by livestock would become available to wildlife, and larger numbers of wildlife could be supported, although the total herbage available would decline.
b. The yield of quality water would be improved.
c. Storm-runoff and sediment loads would be significantly reduced.
d. In general, environmental quality would be maintained or enhanced (table 58).

The use of Strategy A (no livestock) would directly and adversely affect thousands of farmers and ranchers currently using the forest-range. The public would be affected indirectly, and probably adversely, through changes in costs of livestock production. Adversely affected would be those western rural communities that depend heavily on the range livestock industry for economic activity. (Secondary effects were not evaluated in this study.) The tax base and the means of community support would be eroded.

Obviously this option is not realistic. Incentives that could force grazing off the private lands do not exist. It is a possible option on lands administered by Federal agencies, but it has adverse effects that are in conflict with governmental policies to improve rural life and reduce population concentration in urban areas.

Application of management levels B, C, D, and E (some livestock, extensive management,

TABLE 10.—*Area grazed, selected outputs, and costs for Resource Situation—1970 and single strategy management.*

Item	Units	Resource Situation-1970	Strategy				
			No livestock A	Some livestock B	Extensive management C	Intensive management D	Maximize livestock E
Area grazed	Million acres	834.9	0.0	1,176.0	1,153.0	1,161.0	1,163.0
Animal unit month	Million	213.1	0.0	184.0	317.0	566.0	1,739.0
Wood growth	Billion cubic feet	20.5	21.0	20.0	19.0	16.0	6.0
Water yield	Million acre feet	780.1	773.0	743.0	718.0	730.0	746.0
Quality water	Million acre feet	706.3	773.0	732.0	659.0	599.0	510.0
Storm runoff	Million inches	908.9	820.0	802.0	791.0	832.0	924.0
Sediment	Million tons	1,658.3	1,312.0	1,434.0	1,511.0	1,505.0	1,688.0
Total investment cost	Million dollars	858.2	0.0	827.0	1,113.0	2,704.0	8,292.0
Cost per AUM	Dollars	4.03	0.0	4.49	3.51	4.78	4.77

intensive management, and maximizing livestock respectively) indicates the impact of increasingly more intensive livestock management to all of the forest-range environment. In each case it is assumed that all of the land will be managed for grazing at the same intensity.

The B management strategy level is less intensive than the current average level of management. The use of Strategy B would reduce the total investment costs in forest-range facilities for livestock use (table 10). Total AUM production would be below 1970 levels and would not meet current or future demands. The location of production would shift since the analysis assumes a single level of management on each area even though in 1970 many areas were not grazed and some were grazed intensively.

The C management strategy level would produce 317 million animal unit months, which is in excess of current demands and approximately equal to the year 2000 demand level. Annual investment costs of $1,113 million is a significant increase above the 1970 costs, although costs per AUM would decrease from $4.03 to $3.51. Annual wood growth decreases about 7 percent below the 1970 level.

The D management strategy level would produce 566 million animal unit months, a production level in excess of the projected year 2020 need of 394 million. Costs would be $2,704 million, an amount three times greater than the 1970 cost, while wood growth would decrease by 20 percent.

Management at the level of Strategy E (maximizing livestock production) would produce 1,739 million animal unit months or five and one-half times the projected demand for year 2000. Wood growth would be reduced to less than one-third of current levels while sediment would remain about at the 1970 level (fig. 43).

As the intensity of livestock management systems increases, the herbage available and harvested increases. The value of livestock production and the employment in livestock production also increase. Environmental factors are specifically protected in Strategies B, C, and D and, therefore, the losses in environmental value are relatively minor. Application of Strategy E, which emphasizes livestock at the expense of other factors, causes deterioration of environmental quality.

In general, the single strategy management approach either results in more commodity output (grazing) than demanded, and less of the environmental values than demanded, or vice versa. This proved true for individual ecosystems as well as for the Nation. It follows that a combination of management strategies that vary by ecosystem and resource unit could improve the ability of resources to meet the demands for outputs.

None of the single strategy alternatives exhibit sufficient favorable factors to justify their acceptance. Furthermore, as livestock grazing increases, wood growth decreases. This suggests the need (as will be illustrated later) to identify the ecosystems and strategy combinations where the livestock versus wood growth conflict can be minimized. Total investment costs increase as management intensity increases (fig. 44). Many of the alternatives to be discussed later can achieve the same outputs at lower investment cost, with fewer of the qualitative factors showing deterioration.

LEAST-COST MANAGEMENT

The least cost alternatives were evaluated through the use of the Forest-Range Environmental Production Analytical System. The over-riding concern in the analysis is the ability to modify grazing management with a

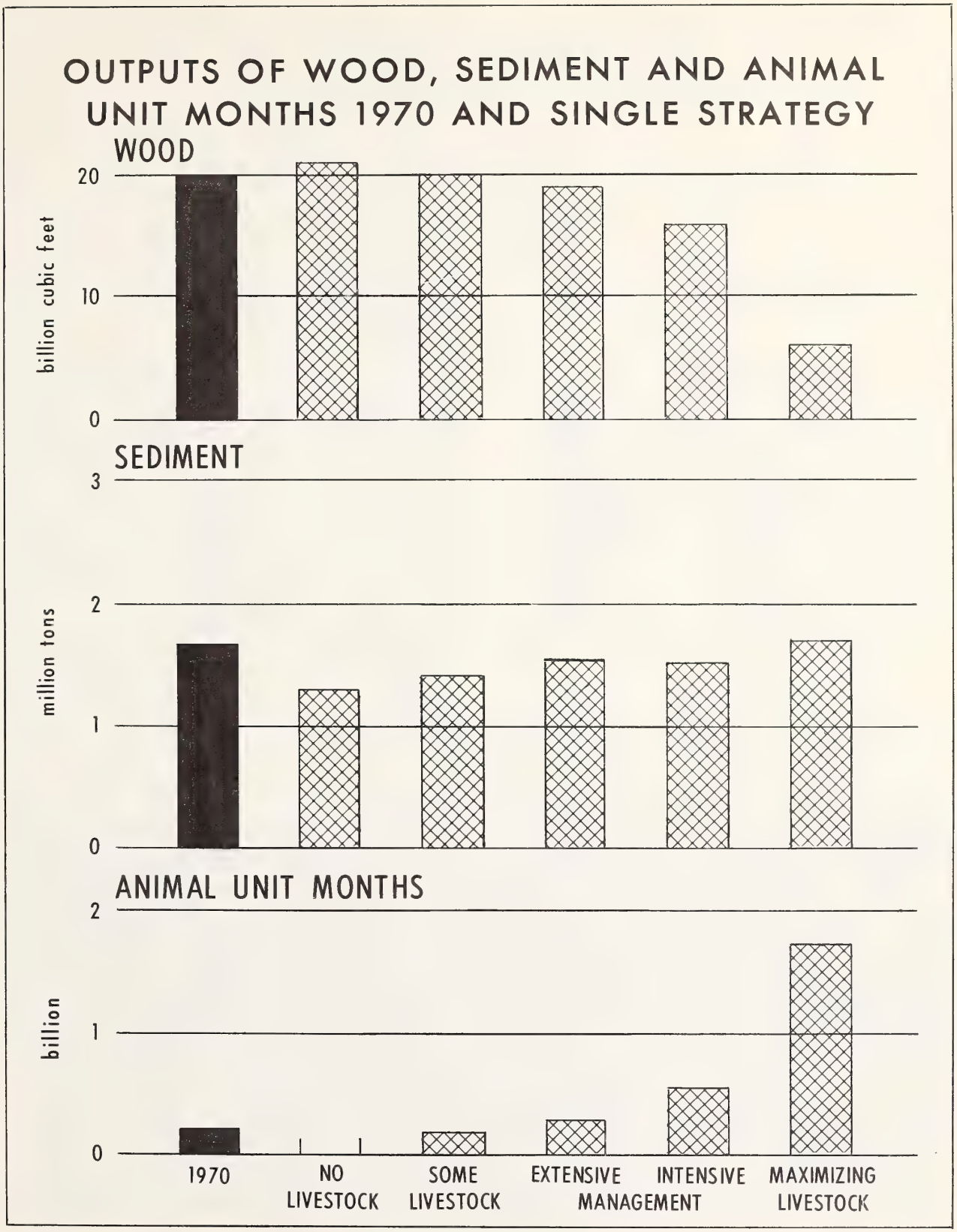
OUTPUTS OF WOOD, SEDIMENT AND ANIMAL UNIT MONTHS 1970 AND SINGLE STRATEGY
WOOD
billion cubic feet
20
10
0
SEDIMENT
million tons
3
2
1
0
ANIMAL UNIT MONTHS
billion
2
1
0
1970
NO LIVESTOCK
SOME LIVESTOCK
EXTENSIVE MANAGEMENT
INTENSIVE MANAGEMENT
MAXIMIZING LIVESTOCK

FIGURE 43.

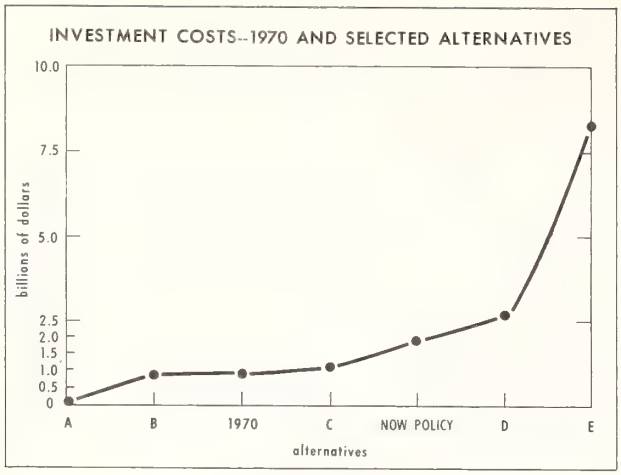

FIGURE 44.

minimum of impact on the other variables.

The initial least-cost alternatives (numbered 1, 2, and 20) primarily served the purpose of identifying the extremes to be anticipated if changes could and would occur on the basis of investment costs alone. These alternatives also provide some perspective by which subsequent programs can be evaluated.

ALTERNATIVE 1

Least-cost

Minimum output required: 223 million animal unit months.

Added Constraints: none.

In this least-cost alternative, AUM production was set near the 1970 output of 213 million. This alternative gave striking results (table 11). Annual investment costs were dramatically reduced from the 1970 cost of $858 million to produce 213 million animal unit months to $291 million. Cost per AUM produced decreases to $1.31, a major decrease when compared to the $4.03 per AUM in 1970. This would be accomplished with major changes in the location of investment in the forest-range resource.

Animal-unit-months production would be increased in the productive group of ecosystems in the Eastern Forest ecogroup. These increases would be at the expense of the Western Range, Western Forest and Great Plains ecosystems (fig. 45). By centering production on the most productive lands, only 31 percent of the forest-range would be used for grazing compared to 69 percent used in 1970. Sixty-eight percent of the AUM output would come from the Plains grasslands, Maple-beech-birch, Prairie, Aspen-birch and Wet grasslands ecosystems. Within the Western ecosystems, Mountain grasslands, Sagebrush, and Annual grasslands (fig. 46) would lead in AUM production. In the Sagebrush ecosystem, about 25 percent of the lands would be grazed, but total land areas only under intensive management, and then in strategies D and E in the high productivity classes.

National wood growth would be increased moderately under this strictly least-cost alternative, with the growth affected more in some ecosystems than others as grazing management shifts among ecosystems to meet the least-cost criteria. From the national position, products other than animal unit months show several favorable trends, primarily because fewer acres would be grazed. The only principal detrimental effects would be a disemployment in the range industry, and this is particularly undesirable in areas of persistent unemployment. Output of quality water would increase while sediment would lessen when grazing is reduced or removed from the less productive acreage. The results show that it is possible to maintain AUM production nationally and maintain or improve qualitative values.

TABLE 11.—*Area grazed, outputs, and costs in Resource Situation—1970 and under Alternatives 1, 2, and 20*

Items	Units	Resource Situation-1970	Alternatives		
			1	2	20
Area grazed	Million acres	834.9	372.1	493.4	428.7
AUM's	Million	213.1	222.6	461.6	319.7
Herbage	Million tons	485.5	508.2	669.0	573.5
Wood growth	Billion cubic feet	20.5	21.3	19.4	20.5
Water yield	Million acre feet	780.1	779.2	781.1	778.8
Quality water	Million acre feet	706.3	773.4	743.3	747.6
Storm runoff	Million inches	908.9	849.3	869.9	857.8
Sediment	Million tons	1,658.3	1,441.2	1,448.3	1,450.3
Total investment cost	Million dollars	858.2	291.0	916.5	531.7
Cost per AUM	Dollars	4.03	1.31	1.99	1.66

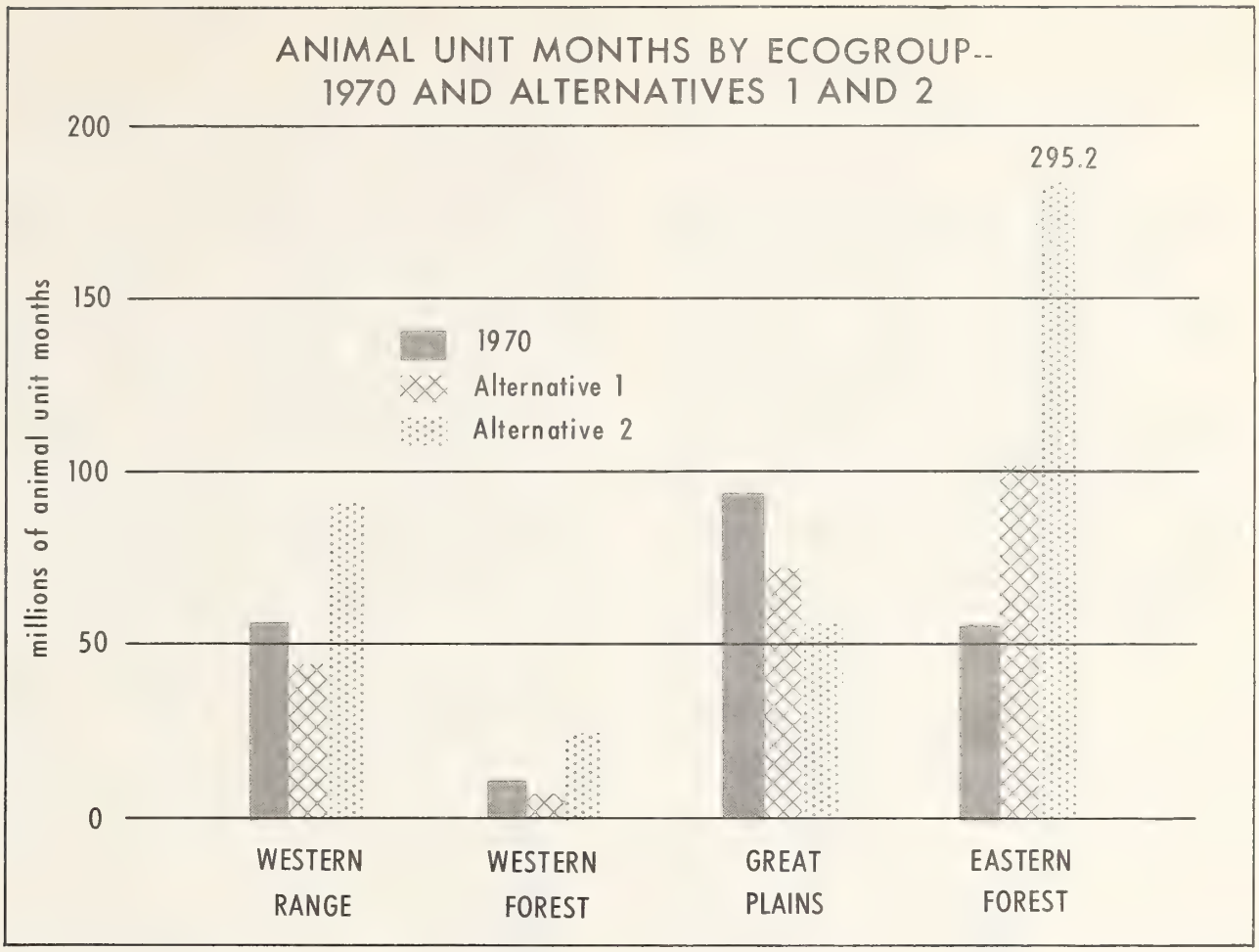

FIGURE 45.

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FIGURE 46.—Annual grasslands would be an important producer of animal unit months under least cost grazing management.

ALTERNATIVE 20

Least-cost

Minimum output required: 320 million animal unit months.

Added constraints: none.

This alternative is analyzed at a production level equal to the demand level of year 2000. Grazing would occur on 429 million acres compared to 835 million in 1970, a decrease of 49 percent (table 11). No significant change in intensity of overall management occurs under Alternative 20 as compared to 1970. In 1970, 77 percent of the land was grazed under management Strategies B (some livestock) and C (extensive livestock), while under Alternative 20 the acreage of land managed at these levels of intensity would increase to 80 percent. Under Alternative 20 the acreage managed under Strategy D (intensive livestock) and Strategy E (maximize livestock) would increase to 20 percent as compared to 13 percent so managed in 1970. These increases also include the reduction of exploitatively grazed acreage from 10 percent in 1970 to zero in Alternative 20.

The decrease in total acreage grazed under Alternative 20 would be distributed disproportionately among the ecogroups (fig. 47). The greatest decrease, 263 million acres or 77 percent would occur in the Western Range. A similar major reduction would occur in the Western Forest ecogroup where acres grazed drops from 97 million in 1970 to 24 million under Alternative 20—a reduction of 63 million acres or 65 percent. A decrease of 68 million acres or 42 percent reduces the acreage grazed in the Eastern Forest ecogroup from 160 to 92 million acres. Acreage grazed in the Great Plains ecogroup remains essentially unchanged between the 1970 level of 217 million acres and the Alternative 20 level of 215 million acres. The shifts in acres grazed under Alternative 20 thus show grazed acreage to be reduced from 86 to 23 percent of total land area in the Western Range; from 60 to 15 percent in the

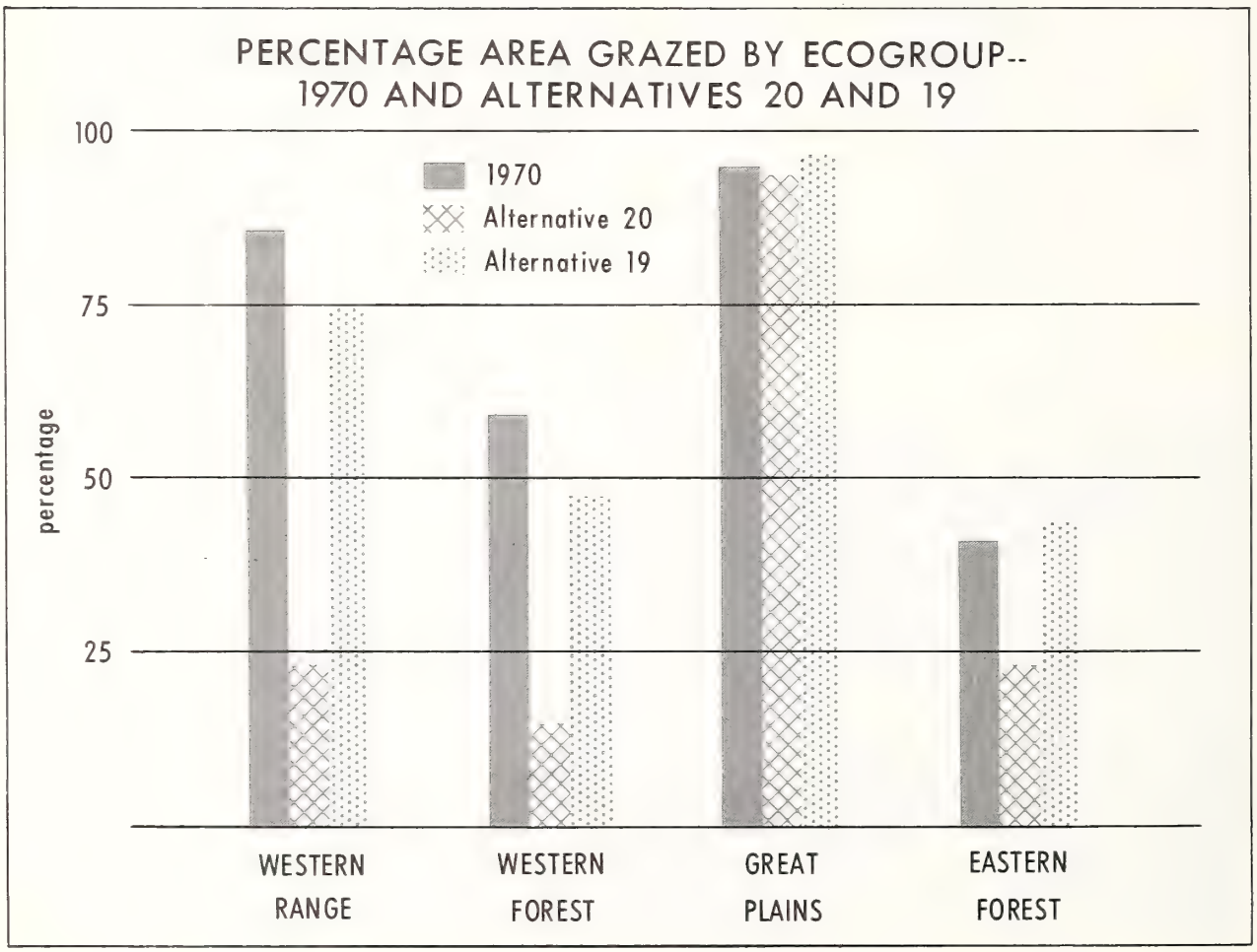

FIGURE 47.

Western Forest; from 41 to 23 percent in the Eastern Forest, but only from 95 to 94 percent in the Great Plains.

Intensity of management also changes under Alternative 20 as compared to 1970. In 1970, 117 million acres of Western Range were grazed under Strategy B, but in Alternative 20 only about 100 thousand acres of the management would be at the B level (table 12). Under Alternative 20, 59 percent of grazed acreage would be managed under Strategy C, 23 percent in D, and 18 percent in E as compared to 1970, when 32 percent was under Strategy B, 53 percent under Strategy C, 8 percent under D, 4 percent under E and 3 percent under Strategy X. Thus this efficiency solution suggests grazing fewer acres and increasing the intensity of management.

While total acreage of Great Plains grazed remains relatively unchanged between 1970 and Alternative 20, the intensity of management would decrease. Acreage managed under Strategy B would increase from 23 to 80 million acres, or from 11 percent to 37 percent; and acreage grazed under Strategy C would decrease from 142 to 132 million acres. Acres under Strategy D would decrease from 19 million to 2 million acres, or from 9 to 1 percent. Only about 100 thousand of the 31 million acres grazed in Strategy E in 1970 would be managed at Strategy E under Alternative 20.

The intensity of management would increase for the Eastern Forest ecogroup under Alternative 20 with a four-way split of acreage between Strategies B, C, D, and E. In 1970, 72 million acres, or 45 percent of the grazed acreage, was in exploitative management, 27 percent in Strategy B, 20 percent in C, 6 percent in D, and only 2 percent in Strategy E.

Alternative 20 would demand by decree the elimination of exploitative grazing and therefore a major improvement in overall management. One adverse effect of this alternative is that 15.4 million acres in the Eastern Forest ecogroup is recommended for management at the intensive Strategy E. This would have a major adverse impact on wood growth, since the strategy requires conversion from forested to unforested range.

TABLE 12.—*Acreage grazed by strategy by ecogroup for Alternative 20*

Million acres

[Totals may not add due to rounding]

Item	Ecogroups				
	Western Range	Western Forest	Great Plains	Eastern Forest	Total
Total acres grazed	98.3	23.8	215.1	91.5	428.7
Acres grazed by strategy					
B	0.1	5.3	80.4	22.8	108.6
C	57.1	16.6	132.3	29.6	235.6
D	23.0	1.6	2.3	23.7	50.6
E	18.1	0.4	0.1	15.4	34.0

Total animal unit months produced under Alternative 20 would increase 50 percent as specified. The increase is not shared equally by either the ecogroups or by the three ownerships.[12] The production of animal unit months on the Western Range ecogroup would remain essentially unchanged at 56 million (table 57). Production on the Western Forest ecogroup would decrease from 11 to 8 million animal unit months while on the Great Plains it would drop from 93 million to 80 million. These changes would take place in the face of an overall increase in animal unit months of 50 percent. The remaining ecogroup, Eastern Forest would produce the increase. Production in this ecogroup would increase from 53 million to 175 million animal unit months, a gain of 226 percent. This again represents a major shift in the location of grazing.

The possibilities shown in Alternative 20 point out the potential and probable future competitiveness of the Eastern Forest ecogroup in the livestock industry. It also illustrates that as the cost per AUM increases in the Western Range, the potential productivity of the Eastern Forest ecogroup will move closer to overcoming those external factors that would appear to slow production shifts.

Alternative 20 would result in no change in national water yield and wood growth from the Resource Situation—1970, a favorable response. Improvements at the national level would result from increases in yield of quality water and reductions in storm runoff and sediment loads.

No change or some improvements over 1970 were also indicated for all of the variables measured by the qualitative indices except for resident cultural heritage (table 58). The reduction in resident cultural heritage results from the massive reduction in areas devoted to "ranching activities." The improvement in the other qualitative values also occurs for the same reason. That is, since this analysis is limited to the evaluation of management of grazing, the land not used for livestock becomes largely devoted to producing environmental qualities.

The costs of this alternative would be substantially below 1970 costs. Investment costs of $858 million would be reduced to $532 million. Since production would also change, a more

[12] National Forest System, other Federal, and non-Federal.

meaningful cost is the cost per animal unit month produced, which would decline from $4.03 to $1.66. The cost per acre grazed would increase, however, because the fewer acres used would be managed more intensively.

ALTERNATIVE 2

Least-cost

Minimum outputs required: 462 million animal unit months.

Added constraints: none.

Analysis at this production level revealed a major national cost reduction when compared to the 462 million AUM Now Policy level (table 9). Costs dropped from $1,960 million under the Now Policy resource allocation to $917 million. A similar decrease occurred in cost per AUM. Now Policy costs of $4.25 per AUM dropped to $1.99 per AUM under Alternative 2. Thus, the analysis exhibits again that investment costs involved in producing AUM's could be drastically reduced using the least cost criterion. On the other hand, the investment costs per AUM increased over the $1.31 costs of Alternative 1 at 223 million AUM's.

Production increases were centered in the East (fig. 45). Oak-hickory, Longleaf-slash pine, Maple-beech-birch, and Aspen-birch ecosystems accounted for 76 percent of the expansion. However, production increases also would occur on the Western Range and Western Forest ecogroups while decreasing in the Great Plains. Under this alternative, area grazed by livestock would shrink from 835 million acres to 494 million acres or to 41 percent of the forest-range. The major downward adjustments in acres grazed would occur in the Western Range and Western Forest ecogroups where AUM production would increase. Acres grazed in the Great Plains ecogroup would drop slightly together with AUM production. Again investigation of non-AUM output values showed few changes from the present situation (table 58).

Quality water shows an increase and wood growth exhibited a significant reduction from the 1970 situation, with the major loss in wood growth occurring in the Oak-hickory ecosystem.

A major policy consideration under this least-cost alternative is the large disinvestment in facilities in parts of the West and the difficulties it would bring to communities there that are dependent on the livestock industry. While the trend toward larger percentage of grazing to occur in the East in the future has been documented earlier in this report, the rate of change implied by this alternative was not substantial.

ALTERNATIVES 10, 11, 12, 13, AND 14

Least-cost

Minimum outputs required:

Alternative 10—223 million animal unit months

Alternative 11—267 million animal unit months

Alternative 12—334 million animal unit months

Alternative 13—412 million animal unit months

Alternative 14—461 million animal unit months

Added constraints:

AUM production in selected Eastern Forest ecosystems would be held to 1970 levels or to small increases. Acreage in a resource unit grazed in 1970 could increase but not decrease.

These five alternatives were tested to explore the consequences of requiring all land now grazed by domestic livestock to remain in production as total grazing demand was increased. This would alleviate some of the adjustment problems noted in the West and East in earlier alternatives. Constraints as applied would limit grazing on some Eastern Forest ecosystems with high potential. Shifts could occur by changes in intensity of management and allowing new lands to be grazed.

AUM production under Alternative 10 would be approximately equal to that of the Resource Situation—1970 level of output, while Alternative 12 closely approximated the demanded AUM level for year 2000.

Production of animal unit months was basically centered in the Great Plains and Eastern ecosystems. Expansion of AUM production would occur in the Loblolly-shortleaf pine and Eastern hardwood ecosystems, causing wood growth to fall as AUM output expanded. However, the other outputs did not exhibit a significant decrease, and in several ecosystems quality water yield and sediment yield show an improvement over the 1970 situation. The ecosystems in the Western Range and Western Forest, under Alternative 10, would be generally managed under Strategy B. However, there are four notable exceptions in the West. Annual grasslands were at management Strategies C to E, while the most productive Sagebrush lands were placed under management Strategies D and E. Mountain meadows and 50 percent of the most productive Mountain grasslands were set under management Strategy C.

ALTERNATIVES 15, 16, AND 17

Least-cost

Minimums required:

Alternative 15—267 million animal unit months

Alternative 16—334 million animal unit months

Alternative 17—412 million animal unit months

Added constraints:

Limits on percent change in acreage of a resource unit grazed.

Strategy E prohibited on Federal lands.

Strategy E prohibited on selected resource units of non-Federal lands.

Grazing prohibited in selected ecosystems.

This series of alternatives was tested to focus attention on two major policy considerations. In order to control investment and disinvestment in various ecosystems, a constraint was entered that allowed only a 5 percent yearly rate of change in investment from the Resource Situation—1970 within each ecosystem. Thus, 10-year (1970 to 1980) and 20-year (1980 to 2000) transition periods were required which would limit the impact on local areas due to policy change. Use of Strategy E was not permitted on non-Federal lands in order to recognize multiple use considerations, especially wood growth, and to limit increases in grazing which, while efficient, were unrealistic.

Alternatives 15, 16, and 17 indicate that largescale improvements in accompanying outputs would be possible by selective management of the range. Improvements in accompanying outputs would come mainly from the non-Federal sector and would result primarily from abandonment of exploitative grazing, Strategy X. The present performance of the Federal agencies in the accompanying product area is generally high.

Evaluation of these alternatives reveals the same basic results as shown in those alternatives discussed earlier. Production of animal unit months tended to shift toward the most productive lands, thus, concentrating output on fewer acres. This enabled costs per AUM to drop as low yield acreages went out of production until finally increased requirements for production forced cost per AUM upward. Expansion of production occurred mainly within the Eastern Forest Ecogroup (table 13). Under Alternative 16 AUM's produced in the Eastern Forest show an increase of 201 percent over 1970, while the total national production increases by only 57 percent. Production on the Western Range and Western Forest would increase by 26 and 25 percent, respectively. The Great Plains ecogroup shows a 5 percent reduction in AUM production in spite of the 5 percent increase in acreage grazed. Land under intensive management accounts for much of the total expansion. This is intensively managed land, mainly in non-Federal ownership. Only small increases take place on Federal land.

Land grazed would drop from 835 million acres (1970 situation) to 721 million acres under Alternative 16 as grazing shifts to the more productive areas and investments are made more efficiently. This is not nearly as radical a shift in acreage as indicated under Alternative 1, where only 372 million acres would be grazed. Under the Alternative 1 shifts, the Western Range acreage grazed would drop about 4 percent, Western Forest about 37 percent and Eastern Forest about 47 percent. Acreage grazed in the Great Plains would increase 5 percent.

These alternatives would favor the Eastern Forest ecosystems. However the shift to the Eastern Forest ecosystems would be accompanied by an expected reduction in acreage due to application of intensive management to the highly productive resource units in these

TABLE 13.—*Production in animal unit months and acres grazed by ecogroup, when disinvestment and investment are restricted, and multiple use constraints are used on Federal and some non-Federal lands*

Ecogroup	Resource Situation-1970	Policy Alternative		
		15	16	17
	Production			
	Million AUM's	*Million AUM's*	*Million AUM's*	*Million AUM's*
Western Range	56.1	68.2	70.8	72.9
Western Forest	10.7	12.3	13.5	13.2
Great Plains	92.8	95.5	88.5	89.6
Eastern Forest	53.5	91.0	161.2	236.3
Total	213.1	267.0	334.0	412.0
	Acres grazed			
	Million acres	*Million acres*	*Million acres*	*Million acres*
Western Range	360.8	375.7	346.2	201.1
Western Forest	97.2	76.2	61.2	25.3
Great Plains	217.1	227.8	228.3	217.9
Eastern Forest	159.8	127.3	85.2	84.8
Total	834.9	807.0	720.9	529.1

ecosystems. Similar shifts in management would occur within the other ecogroups, resulting in less land grazed.

In each step of the analysis up to this point, additional information and understanding of the forest-range environment as a complex of inputs, management, outputs, and values were established. Shifting production according to optimal solutions could reduce the Nation's cost of achieving specified AUM outputs to between one-half and one-fourth of the existing or planned costs. At the same time these outputs could be met from much less land than is now being grazed. Major increases in grazing in the East and South would be required to achieve these efficiencies at most production levels.

If unconstrained least-cost programs were to be implemented, grazing would be reduced on some of the traditional range ecosystems. Furthermore, increases in the Nation's livestock production would not be shared proportionally by all ownerships. The cheapest opportunities to increase animal unit months are in the Eastern and Southern ecosystems where there are higher proportions of non-Federal land. On the non-Federal land it is very important that exploitative management be eliminated because of the large acreage involved. The problem is to find a means to effect needed changes with minimum impact on existing institutions and investors.

ALTERNATIVE 19

A least-cost constrained alternative

Minimum outputs required:

320 million animal unit months of grazing.

20.5 billion cubic feet of wood growth.

780 million acre feet of water yielded.

706 million acre feet of quality water yielded.

Maximum outputs permitted:

1,658 million tons of sediment.

Added constraints:

Five percent per year limit on change in grazing strategies.

Strategy E prohibited on Federal lands and on non-Federal forested ecosystems.

Conversion of lands not grazed in 1970 to be grazed in year 2000 limited to 50 percent of total acres.

This alternative was the final one tested and is described here in detail as representative of the evaluation process. The constraints were deliberately restrictive and to a large extent prescribed the distribution of grazing. Included in the specifications of this alternative was the meaningful information accumulated in the evaluation of preceding alternatives.

The constraints for this alternative specified that wood growth, water yield, and quality water for the forest-range environment must be equal to or greater than the quantity of those outputs produced in the Resource Situation—1970. Sediment output was specified to be equal to or less than the quantity in 1970. These outputs could, however, fluctuate by ecosystem and resource units. These constraints, applied to important measures of environmental quality, were specified in this form to insure that regardless of the grazing management program selected, the national objective of preventing deterioration of environmental quality would be met.

The prescribed constraints reflect the application of judgment and knowledge external to the model. (External to the model but internal to the system. This system was not intended to reduce the planning and management to black box magic and requires review and applied judgment.) Thus, the rate of change and amount of grazing allowable in areas not grazed in 1970 was limited on the basis of judgment as to what was possible. This alternative had a prescribed 50 percent increase in the number of animal unit months required, 320 million, and is representative of, and evaluated in terms of year 2000.

Alternative 19 revealed only a minor adjustment from the 835 million acres (70 percent of total acres) grazed in 1970. Under Alternative 19, 789 million acres, or 66 percent would be grazed (table 14). Ungrazed acreage would increase from 367 million acres to 413 million

TABLE 14.—*Ungrazed and grazed acreage by strategy by ecogroup for total forest-range under Alternative 19*

(Million acres)

[Totals may not add due to rounding]

Item	Western Range	Western Forest	Great Plains	Eastern Forest	Total
Area ungrazed	104.7	83.3	5.9	218.6	412.5
Area grazed	313.8	77.3	223.0	174.8	789.1
Area grazed by strategy					
Some livestock (B)	61.0	32.6	16.7	45.4	155.8
Extensive management (C)	136.2	31.0	155.6	36.7	359.5
Intensive management (D)	75.5	13.7	26.6	92.7	208.6
Maximize livestock (E)	41.1	0	24.1	0	65.2
Percent grazed	75	48	97	44	66

acres. The acreage grazed under management Strategies B and C would decrease from 641 million acres to 515 million acres. Acreage in Strategies D and E would increase to 274 million acres (Strategies D and E) from 194 million acres (Strategies D, E, and X) in 1970.

Because the ecogroups have different characteristics, the same analysis resulted in different responses by each ecogroup. The Western Range ecogroup under Alternative 19 was 75 percent grazed, compared to 86 percent in 1970 and 23 percent in the unconstrained Alternative 20 (fig. 47). Under Alternative 19, ungrazed acreage increased twofold, from 58 million acres to 105 million acres. Acreage under management Strategies B and C decreased from 308 million acres to 197 million acres. Area under intensive management and maximized livestock production (Strategies D and E) increased from 43 million acres to 117 million acres. Acreage managed under Strategy B and Strategy C decreased from 28 and 46 percent in 1970 to 15 and 33 percent, respectively, under Alternative 19. On the other hand, between 1970 and Alternative 19, acreage under Strategy D would increase from 7 to 18 percent and Strategy E from 7 to 18 percent and Strategy E from 4 to 10 percent. Acreage under exploitative grazing (Strategy X) dropped to zero from more than 2 percent in 1970 (fig. 48).

In the Western Forest ecogroup the acreage not grazed would increase from 1970 level of 63 million acres to 83 million acres under Alternative 19. Acreage under management Strategies B and C would decrease from 93 million acres to 64 million acres. Acres grazed under Strategies D and E would increase from 5 million acres to 14 million acres. In the Western Forest ecogroup, ungrazed acreage would increase from 40 percent of total area in 1970 to 52 percent under Alternative 19. At the same time, therefore, all of the acreages managed in each strategy would decrease except for Strategy D, which shows an increase from less than 1 percent to nearly 9 percent of the grazed acreage. This reflects a common element inherent throughout the analysis, which is to concentrate higher levels of management on the more productive lands. Thus, higher output is possible from fewer acres. Forty-eight percent of the Western Forest ecogroup would be grazed under Alternative 19, as compared to 60 percent in 1970 and 15 percent under Alternative 20.

In the Great Plains the acreage not grazed would decrease from 12 million acres to 6 million acres. The grazed acreage in the Great Plains decreased under Strategy B from 23 to 17 million acres, or from 10 to 7 percent of the grazed acreage. Strategy C acreage would increase from 142 to 156 million acres, or from 62 to 68 percent. Acreage under Strategy D would increase from 19 to 27 million acres, or from 9 to 12 percent, while under Strategy E it would decrease from 31 to 24 million acres or from 14 to 11 percent. About 900 thousand acres managed under Strategy X in 1970 is eliminated under Alternative 19. Ninety-seven percent of this ecogroup would be grazed as compared to 95 percent in the Resource Situation—1970 and 94 percent under Alternative 20.

The impacts of Alternative 19 on the Eastern Forest ecogroup would be substantial. Grazed acreage would increase from 160 million acres to 175 million acres. One major change in management strategies would occur in the Eastern Forest. Acreage under Strategy D would increase from 2 percent of the grazed acreage to nearly 24 percent, or an increase from 10 million to 93 million acres. Acres managed under the other strategies would remain generally unchanged, except for the elimination of 72 million acres managed under exploitative systems in 1970. Forty-four percent of the ecogroup would be grazed, as compared with 41 percent in the Resource Situation—1970 and 23 percent under the unconstrained least-cost Alternative 20.

Simultaneously, with the changes in grazed acreage, production of animal unit months would increase from the 1970 level of 213 million to the demand level for year 2000 of 320 million. Increases would occur in all ecogroups under Alternative 19 but greatest in the Eastern Forest (fig. 49).

In the Western Range ecogroup the production of grazing would increase from 56 million animal unit months in 1970 to 78 million in year 2000, an increase of 39 percent, under conditions of Alternative 19 (table 57). Under Alternative 20 production would have been 57 million animal unit months, essentially unchanged from the 1970 level.

The Western Range ecogroup contains a considerable number of resource units that are competitive with other areas. This total production level in the Western Range ecogroup, however, is maintained only through concentration of intensive management strategies on the more productive resource units.

Production under Alternative 19 would increase by 27 percent over 1970 in the Western Forest ecogroup. Under Alternative 20, production would decrease from 1970 level by 21 percent, the largest decrease by any ecogroup. The increased production under Alternative 19 results from the constraints which require only a minimum amount of acreage in this ecogroup to be grazed at the 1970 management level. Since this analysis specified least-cost, the requirement of continued grazing forced the selection of more intensive management on

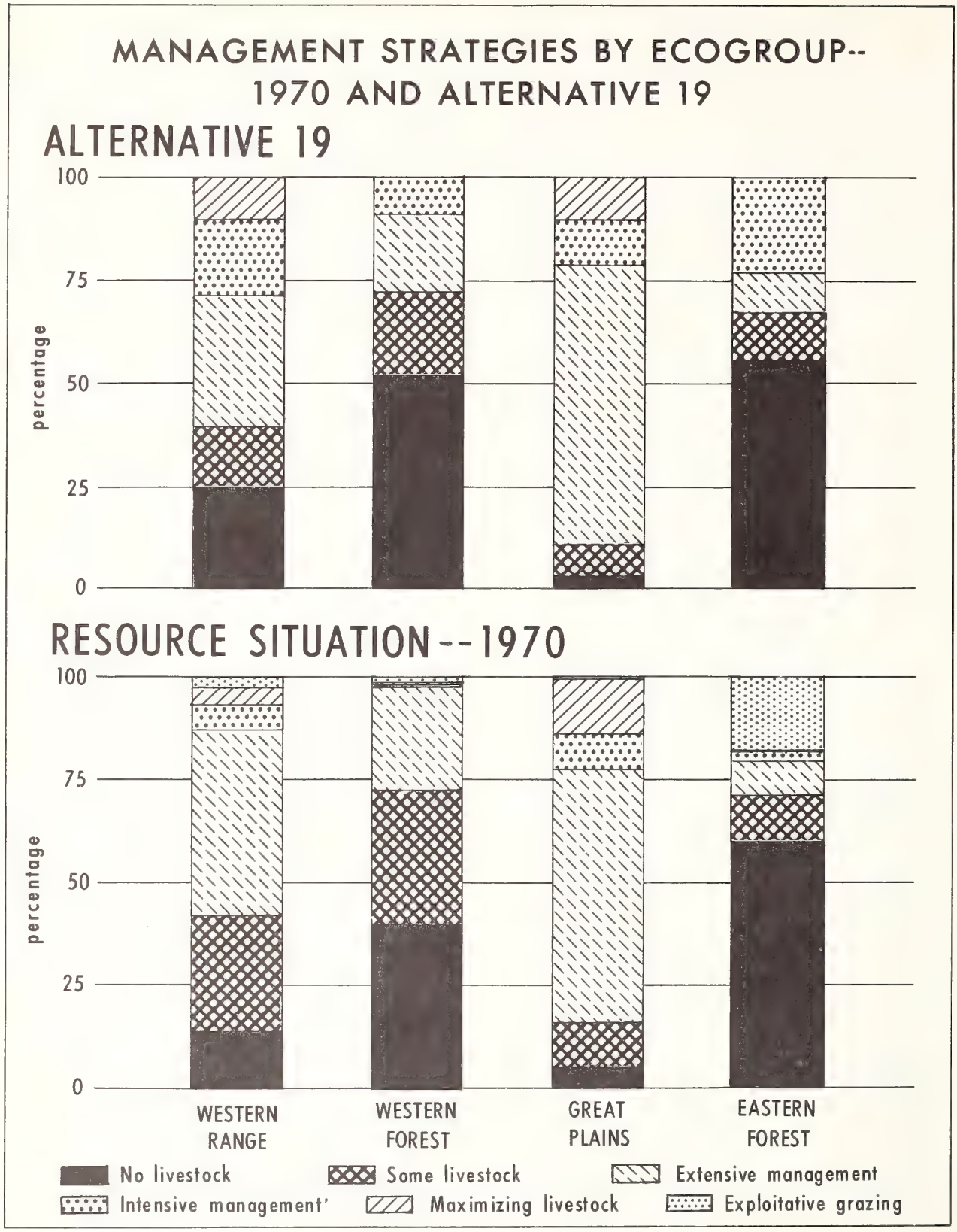
MANAGEMENT STRATEGIES BY ECOGROUP--
1970 AND ALTERNATIVE 19
ALTERNATIVE 19
100
75
50
25
0
percentage
RESOURCE SITUATION--1970
100
75
50
25
0
percentage
WESTERN RANGE
WESTERN FOREST
GREAT PLAINS
EASTERN FOREST
No livestock
Some livestock
Extensive management
Intensive management'
Maximizing livestock
Exploitative grazing

FIGURE 48.

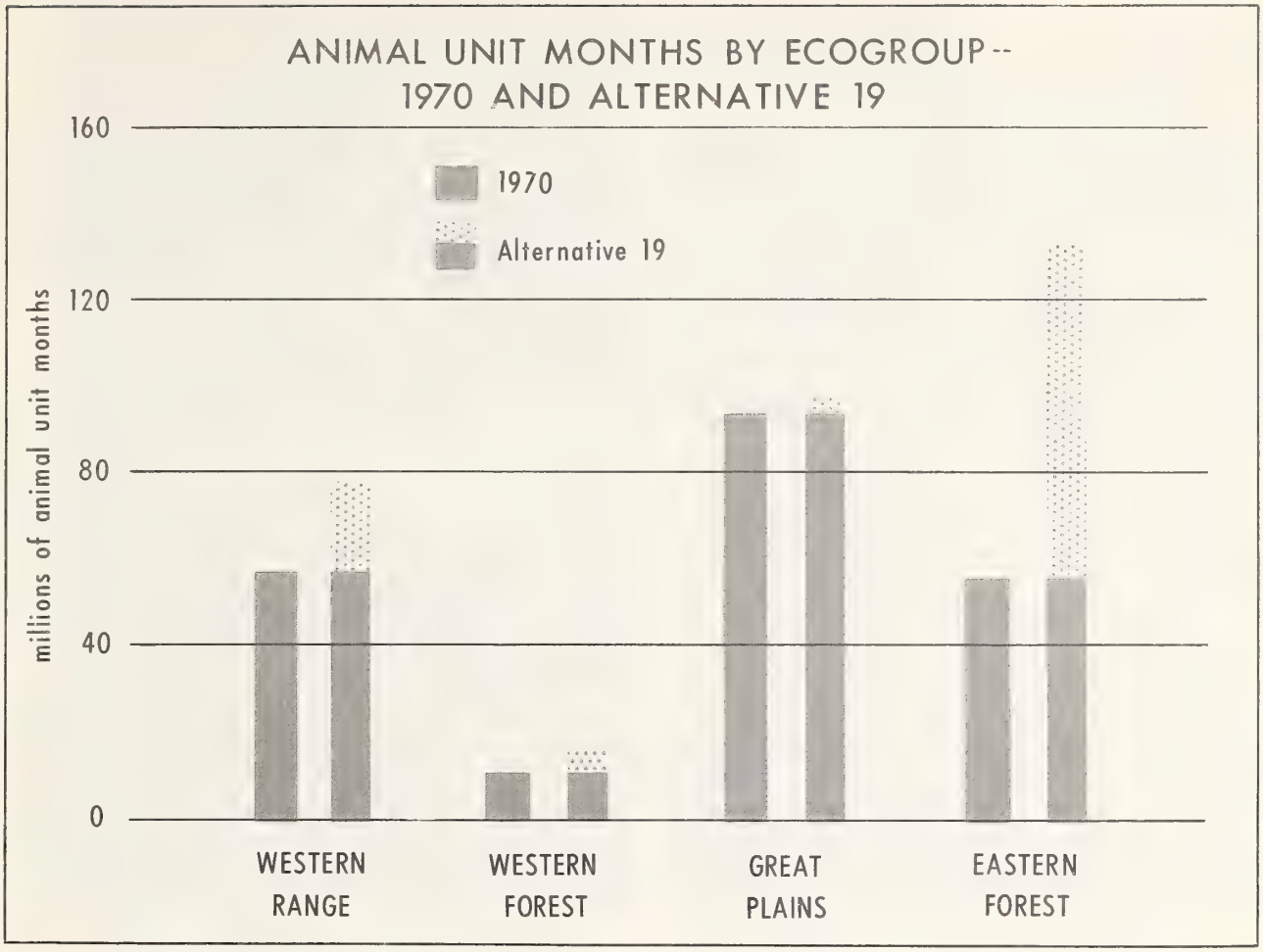

FIGURE 49.

some resource units because they produced at a lower cost per animal unit month.

Grazing would increase in the Great Plains ecogroup from 93 million animal unit months in 1970 to 96 million in year 2000 under the conditions of Alternative 19. This is an increase of only 3 percent over the 1970 level, but under the unconstrained Alternative 20, production in the ecogroup would have decreased by 14 percent. The difference between the constrained Alternative 19 and the unconstrained Alternative 20 is the limit on change in grazed acreage and in the management strategies. The capacity for increased production in the Eastern Forest ecogroup through Strategy E management in some areas under Alternative 20 is eliminated in Alternative 19. Thus, production would be forced back to the Great Plains, the next most efficient ecogroup.

In the Eastern Forest ecogroup the production of grazing would increase from 53 million animal unit months in 1970 to 132 million in year 2000 under the conditions of Alternative 19. This is an increase of 147 percent, while the national total is increasing by only 50 percent. However, under the unconstrained least-cost Alternative 20, with a total production of 320 million animal unit months, the output for the Eastern Forest ecogroup would be 174 million animal unit months, a 230 percent increase. Since the basic criteria of least-cost for allocating grazed acres remains the same, the difference between 132 million and 174 million animal unit months results from the limits placed on change and the prohibition of the use of Strategy E in forested ecosystems.

The impact of the conditions of Alternative 19 on the acreage grazed varies among the three ownerships. The total acreage of the forest-range environment grazed would increase, and this increase is shared by all ownerships. The grazed acreage in non-Federal ownership would increase only slightly, from 564 million acres in 1970 to 570 million in year

2000. Grazed acreage on National Forest System lands would increase by 15 million acres to 101 million acres. Grazed acreage on other Federal lands would increase by 25 million acres to 165 million acres. Total acreage grazed would increase in both Federal ownerships by 18 percent over 1970. The intensity of management applied varies among ownerships.

A major variation in animal unit months produced occurs under Alternative 19. In 1970 production on the National Forest System was 11 million animal unit months or 5 percent of the total from the forest-range environment (table 15). Under Alternative 19, the National Forest System would produce 6 percent of the animal unit months, as compared to 8 percent under Alternative 20. Production on the National Forest System under Alternative 19 would increase by 78 percent over the 1970 level. On lands administered by other Federal agencies, production would increase by 49 percent over the 1970 level, while on non-Federal lands the increase would be 48 percent.

TABLE 15.—*Animal unit months produced by ownership in 1970 and under Alternatives 19 and 20*

(Totals may not add due to rounding)

Ownership	Resource Situation—1970	Alternative			
		19		20	
	Million AUM's	*Million AUM's*	*Percent increase*	*Million AUM's*	*Percent increase*
National Forest System	11.3	20.1	78	26.1	131
Other Federal	18.8	28.1	49	31.4	67
Non-Federal	183.1	271.5	48	262.1	43
Total	213.1	319.7	50	319.7	50

Four ecosystems have been selected to illustrate details of management under Alternative 19 by resource units within ecosystems. The ecosystems selected were Sagebrush from the Western Range ecogroup, Lodgepole pine from the Western Forest ecogroup, Plains grasslands from the Great Plains ecogroup, and Loblolly-shortleaf pine from the Eastern Forest ecogroup (fig. 50).

In each ecosystem the management levels were widely distributed within each resource unit. Tables 16 through 19 show how the acreage for each resource unit would be most efficiently allocated for management under Alternative 19. This distribution of acres across strategies is the most efficient possible, given the demands for outputs, costs, and constraints included in this alternative. Similar information by ownership is shown in Tables 59 through 62.

If the analytical procedures had not included the constraints on change, management would have been concentrated in two or three strategies, and in many situations the entire resource unit would have been allocated to a single optimal strategy. The management mix would have resulted from selection of strategies between resource units rather than within the resource unit.

The optimal strategy for a resource unit is the single best option, given the simultaneous consideration of other resource units and the quantity of outputs required. The optimal strategy indicates the direction toward which management would move if demands were increased to a higher level, or if less of the forest-range environment were available for livestock grazing.

Management in the Sagebrush ecosystem was concentrated at the extensive (C) and intensive (D) Strategies (table 16). When considered in an unconstrained context, (except that Strategy E would be prohibited on Federal lands), the optimal management was the intensive Strategy (D) on Federally administered resource units and the maximized livestock (Strategy E) on non-Federally owned resource units (table 61). A high proportion of the Sagebrush ecosystem in the low productivity class and poor condition was allocated for no grazing (Strategy A). This low-producing, poor-condition range was not competitive with the Sagebrush areas in higher productivity classes and in better condition.

Acreage of the Lodgepole pine ecosystem under Alternative 19 conditions was distributed for grazing principally to management Strategy B (table 17). However, in this forest ecosystem about 62 percent of all the land would not be grazed (Strategy A). Of the remaining 38 percent that would be grazed, about two-thirds would be managed at Strategy B with the remainder grazed at Strategy C and D levels.

Management tends to concentrate in Strategy B for the moderately low and low-productivity classes with the exception of the resource unit in the moderately low-productivity class with the seedling, sapling, and pole stand-size class. Grazed acreage of the high and moderately high productivity classes takes this pattern primarily because of the limits on change from the level of management in 1970.

The management changes when unconstrained optimal management levels are considered. The analysis of this ecosystem has fewer optimal cells than some other ecosystems because maximized livestock management (Strategy E) was eliminated from the available choices. The optimal management is generally

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FIGURE 50.—Diversity in the character of ecosystems leads to diversity of management.

TABLE 16.—*Recommended management strategies by resource unit for Sagebrush ecosystem under Alternative 19*

(Thousand acres)

[Parentheses indicate the cells that would receive the initial allocation of land under unconstrained least cost analysis.]

Productivity class	Condition	Strategy				
		No livestock (A)	Some livestock (B)	Extensive mangt. (C)	Intensive mangt. (D)	Maximize livestock (E)
I (High)	Good	120	260	999	(1,804)	—
	Fair	34	179	432	(864)	—
	Poor	—	11	17	(37)	—
II (Moderately high)	Good	4	40	93	(187)	—
	Fair	452	1,131	6,552	(11,164)	3
	Poor	42	202	744	(1,307)	—
III (Moderately low)	Good	10	49	145	(245)	—
	Fair	360	1,649	6,164	(7,564)	(3,310)
	Poor	218	1,289	4,428	(4,861)	(2,444)
IV (Low)	Good	10	84	95	(225)	—
	Fair	126	1,342	2,456	(4,577)	185
	Poor	(13,347)	5,228	6,352	699	64

TABLE 17.—*Recommended management strategies by resource unit for Lodgepole pine ecosystem under Alternative 19*

(Thousand acres)

[Parentheses indicate the cells that would receive the initial allocation of land under unconstrained least cost analysis.]

Productivity class	Stand-size class	Strategy				
		No livestock (A)	Some livestock (B)	Extensive mangt. (C)	Intensive mangt. (D)	Maximize livestock (E)[1]
I (High)	Non-stocked	1	3	(3)	—	—
	Seedling, sapling, and pole	2	18	3	(21)	—
	Sawtimber	28	1	—	(5)	—
II (Moderately high)	Non-stocked	2	23	30	—	—
	Seedling, sapling, and pole	30	261	39	(303)	—
	Sawtimber	335	63	—	—	—
III (Moderately low)	Non-stocked	(125)	95	13	—	—
	Seedling, sapling, and pole	159	1,098	(157)	1,273	—
	Sawtimber	(1,140)	332	89	—	—
IV (Low)	Non-stocked	(107)	82	10	—	—
	Seedling, sapling, and pole	(7,165)	1,724	460	—	—
	Sawtimber	(2,803)	900	234	—	—

[1] Maximizing for livestock production was prohibited by definition.

TABLE 18.—*Recommended management strategies by resource unit for Plains grasslands ecosystem under Alternative 19.*

(Thousand acres)

[Parentheses indicate the cells that would receive the initial allocation of land under unconstrained least cost analysis.]

Productivity class	Condition	Strategy				
		No livestock (A)	Some livestock (B)	Extensive mangt. (C)	Intensive mangt. (D)	Maximize livestock (E)
I (High)	Good	430	1,209	(2,676)	—	—
	Fair	149	460	(892)	—	—
	Poor	32	101	24	(156)	—
II (Moderately high)	Good	796	1,520	(25,122)	1,026	1,447
	Fair	69	114	(974)	29	—
	Poor	7	54	114	(194)	—
III (Moderately low)	Good	1,468	2,939	(51,168)	1,749	1,461
	Fair	1,739	3,481	(60,570)	2,071	1,730
	Poor	13	37	189	(268)	1
IV (Low)	Good	1	3	(42)	1	—
	Fair	11	52	(839)	22	42
	Poor	57	(3,215)	2,088	135	263

in Strategy D for lands in the two higher productivity classes when they are in seedling, sapling, and pole, or saw-timber stand-size classes. In the pure efficiency context, grazing would be eliminated from 5 of the 6 resource units in moderately low and low-productivity classes.

A high portion (83 percent) of the Plains grasslands grazed acreage is managed in the extensive livestock management (Strategy C) category (table 18). An exception was the low-productivity class, poor condition resource unit which was primarily recommended for management at the Strategy B (some livestock) level.

The optimal management level of this ecosystem, given the demands and constraints specified for year 2000, is Strategy C for 8 of the 12 resource units, which is not greatly different from the recommended program of Alternative 19. Of the four remaining resource units, the three units in poor condition and the top three productivity classes were recommended for intensive management (Strategy D) because of the high response of these lands to intensive management. The remaining resource unit, with low productivity and poor condition, was recommended for grazing at the Strategy B level.

The recommended levels of management in Alternative 19 for the Loblolly-shortleaf pine

TABLE 19.—*Recommended management strategies by resource unit for Loblolly-shortleaf ecosystem under Alternative 19*

(Thousand acres)

[Parentheses indicate the cells that would receive the initial allocation of land under unconstrained least cost analysis.]

Productivity class	Stand-size class	Strategy				
		No livestock (A)	Some livestock (B)	Extensive mangt. (C)	Intensive mangt. (D)	Maximize livestock (E)[1]
I (High)	Non-stocked	3	5	—	(8)	—
	Seedling, sapling, and pole	224	(569)	43	(801)	—
	Sawtimber	375	(1,322)	174	(1,627)	—
II (Moderately high)	Non-stocked	35	23	2	(62)	—
	Seedling, sapling, and pole	1,522	(2,835)	324	(4,473)	—
	Sawtimber	1,219	(3,272)	526	(4,302)	—
III (Moderately low)	Non-stocked	63	125	7	(199)	—
	Seedling, sapling, and pole	5,785	16	2,162	(8,599)	—
	Sawtimber	1,120	2,416	350	(3,991)	—
IV (Low)	Non-stocked	77	192	6	(277)	—
	Seedling, sapling, and pole	1,692	9	479	(2,300)	—
	Sawtimber	282	399	39	(727)	—

[1] Maximizing for livestock production was prohibited by definition.

ecosystem varied according to productivity class and stand-size class (table 19). For the resource units in the two highest productivity classes, grazing management was divided between B and D Strategy levels.

Loblolly-shortleaf resource units in the two lower productivity levels were concentrated at the Strategy D level. In these two latter productivity classes, the largest area fell in the seedling, sapling, and pole stand-size class.

Allocation of the Loblolly-shortleaf pine ecosystem to grazing by ownership is of interest (table 62). Intensive level management (Strategy D) was recommended for all resource units in non-Federal ownership, and all resource units in moderately low and low productivity classes in Federal ownership would be in some livestock management, Strategy B. This difference between ownerships reflects the difference between objectives and therefore the difference in constraints placed on the Federal and non-Federal lands. Maximized livestock management (Strategy E) did not occur in this ecosystem because it was specifically excluded from all forested ecosystems.

Quantitative Outputs

The constraints for Alternative 19 specified that the national totals for all forest-range for net annual wood growth, the annual water yield, and the annual quality water yield would be equal to or greater than the output quantity in 1970. Sediment was specified to be equal to or less than the 1970 national level. These values were free to fluctuate, however, within the fixed national total. Alternative 19, therefore, caused no change in wood growth and water yield from the Resource Situation—1970, while the yield of quality water increased (table 20). At the same time sediment yield decreased appreciably. A related reduction in storm runoff was also apparent. This reduction was not required, but it occurred because of the impact of other specifications such as the elimination of exploitative grazing.

While these values were specified at the national level, they were free to fluctuate by ecosystem. By individual ecogroup the impact on wood growth specified in Alternative 19 was generally minor. Annual water yield increased slightly in the Western Range and Great Plains ecogroups, while in the Western Forest ecogroup it remained unchanged. The Eastern Forest ecogroup had a small reduction in water yield.

Qualitative Outputs

Quality water yield decreased in the Western Range, Great Plains, and Western Forest ecogroups, but increased sufficiently in the Eastern Forest ecogroup to improve quality water yield on a national basis. Most of the improvement in quality water yielded in the Eastern Forest ecogroup results from the elimination of exploitative grazing. This elimination of exploitative grazing in the Eastern Forest ecogroup is a highly significant factor in the improvement of all variables evaluated in this analysis.

Storm runoff was generally unchanged between Alternative 19 and the Resource Situation—1970 except for the Eastern Forest ecogroup where a significant improvement occurred. While sediment decreased slightly in the Western Range ecogroup, increased sediment occurred in the Western Forest and Great Plains ecogroups. A major reduction in sedi-

TABLE 20.—*Wood growth, water yield, quality water yield, storm runoff, and sediment by ecogroup in 1970 and under Alternative 19*

(Totals may not add due to rounding)

Item	Unit	Ecogroup								National Totals	
		Western Range		Western Forest		Great Plains		Eastern Forest			
		1970	Alt. 19	1970	Alt. 19	1970	Alt. 19	1970	Alt. 19	1970	Alt. 19
Wood growth	Billion cu. ft.	0.6	0.6	5.5	5.6	0.0	0.0	14.4	14.3	20.5	20.5
Water yield	Million ac. ft.	99.6	100.2	176.2	176.2	17.6	19.4	486.5	484.3	780.1	780.1
Quality water	Million ac. ft.	95.4	92.0	168.7	166.4	6.6	5.5	435.6	463.3	706.3	727.1
Storm runoff	Million in.	134.1	131.1	71.4	71.8	164.1	165.0	539.3	510.2	908.9	878.1
Sediment	Million tons	1,148.4	1,142.4	82.9	95.2	257.1	266.5	169.8	20.2	1,658.3	1,524.3

ment was revealed for the Eastern Forest ecogroup where, in 1970, nearly 170 million tons was deposited in stream channels; under Alternative 19 this would be reduced to less than one-eighth of that amount. This improvement results primarily from the elimination of exploitative grazing (72 million acres of the Eastern Forest ecogroup were under exploitative grazing in 1970).

Comparing the results of Alternative 20 to the Resource Situation—1970 helps to explain some of the changes that occurred under Alternative 19. Under Alternative 20 a significant improvement occurs in quality water yield, storm runoff, and sediment over the Resource Situation—1970 (table 11). These changes are greater than the improvements under Alternative 19 (table 20). Alternative 20 is superior in these aspects because less acreage would be grazed. A large acreage would move to Strategy A—no livestock grazing—with the improvement as indicated in the earlier discussion of Strategy A as a single strategy alternative.

Soil quality, soil stability, air quality, and beauty were not very sensitive at the national level when tested under Alternative 19. Their response to Alternative 19 and to other selected alternatives is presented in table 21. Alternative 19 suggests some improvement in three of these parameters and no improvement in the fourth, air quality. These measurements are most meaningful when evaluating individual ecosystems or resource units. The important consideration, however, is that under the conditions of Alternative 19 (which meets the grazing demands for year 2000), the 50 percent increase in animal unit months could be achieved without deterioration of environmental quality. Alternatives 1, 2, and 20, all of which are unconstrained, also show a similar response.

Review of the qualitative indexes for rare species, non-game birds, carnivores and raptors, and hunting and other recreation indicated no change to slight improvement of these values under Alternative 19 as compared to the Resource Situation—1970 (table 22). Alternatives 1 and 20 showed a slightly better response for rare species, non-game birds, and carnivores-raptors than did Alternative 19. The Alternative 1 and 20 improvements were closely related to the number of acres requiring management at levels of Strategies D or E. Alternative 19 showed no real change from the Resource Sit-

TABLE 21.—*Indexes of soil stability, soil quality, air quality, and beauty in 1970, and for selective alternatives.*

(Qualitative index)

[Qualitative outputs were measured on a scale of 1 to 5: 5–Excellent, 4–Good, 3–Fair, 2–Poor, and 1–Bad.]

Item	Soil stability	Soil quality	Air quality	Beauty
Resource Situation—1970	3.3	3.7	3.5	3.2
Alternatives:				
19	3.4	3.8	3.5	3.3
1	3.5	3.9	3.5	3.3
2	3.5	3.9	3.5	3.3
20	3.4	3.9	3.5	3.3

TABLE 22.—*Indexes of rare species, non-game birds, carnivores and raptors, hunting, and other recreation in 1970, and for selected alternatives*

(Qualitative index)

[Qualitative outputs were measured on a scale of 1 to 5: 5–Excellent, 4–Good, 3–Fair, 2–Poor, and 1–Bad.]

Item	Rare species	Non-game birds	Carnivores and raptors	Hunting	Other recreation
Resource Situation—1970	3.4	3.4	3.5	3.2	2.9
Alternatives:					
19	3.4	3.5	3.5	3.2	3.0
1	3.5	3.6	3.7	3.5	2.9
2	3.4	3.5	3.6	3.3	2.9
20	3.5	3.6	3.7	3.4	3.0

uation—1970 in the index for depressed area impact. This index relates to the percentage of an ecosystem in counties designated as having a chronic low income (fig. 51). Changes in the index indicate the estimated impact on these areas resulting from increase or decrease in livestock grazing associated with the alternative.

The change in location of grazing was not sufficient in any of the alternatives to support the claim that one alternative was superior to another, with the possible exception of the single Strategy Application E, in aiding depressed areas. Application of the unconstrained least-cost Alternatives 1, 2 and 20 would increase unemployment in several depressed areas.

As part of the capability of this analysis, another approach was used to assess the impact on depressed areas of changing the intensity of management. More land in the National Forest System is in counties that are designated as depressed areas than in the other ownerships. Implementation of more intensive range management strategies on selected National Forest System lands, therefore, should contribute more to alleviating economic depression in rural areas than would similar investments on lands in other ownerships (table 23).

A related approach was to superimpose an additional program of investment, for the purpose of benefitting people in designated depressed areas, on a management program previously accepted. An example would be to take one 10.2 million-acre segment of the Pinyon-juniper ecosystem with the highest share of its acreage in depressed area (fig. 52).

Under Alternative 19, 6.2 million acres of Pinyon-juniper would be grazed with 62 percent of that under management strategies B and C, and 38 percent would be grazed under intensive management (Strategy D), at an annual cost of 4.3 million (table 24).

Under a program to improve economic conditions in this segment of the Pinyon-juniper ecosystem, all of the acreage would be intensively managed. This would result in 622,000 added animal unit months, 565,000 additional man-hours of employment, and an additional $5.8 million of gross animal output value. For the added cost of $5.8 million per year, 282

TABLE 23.—*Qualitative response to progressively greater investment in range management on lands in different ownerships*

(Qualitative index)

[Qualitative outputs were measured on a scale of 1 to 5: 5–Excellent, 4–Good, 3–Fair, 2–Poor, and 1–Bad.]

Ownership	Resource Situation-1970	Single strategy applications				
		A	B	C	D	E
National Forest System	1.0	1.0	1.0	1.2	1.5	2.3
Other Federal	1.0	1.0	1.0	1.1	1.1	1.8
Non-Federal	1.0	1.0	1.0	1.1	1.1	1.7

FIGURE 51.—The results of low income.

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FIGURE 52.—Low income is associated with the Pinyon-juniper ecosystem.

TABLE 24.—*An optional management program for depressed areas as applied to a segment of the Pinyon-juniper ecosystem*

Item	Units	Alternative 19	Depressed Area program	Added by program
	(Thousand)			
Total area	Acres	10,230	10,230	0
Total grazed	Acres	6,161	10,230	4,069
Grazed by strategy:				
B	Acres	1,406	0	0
C	Acres	2,389	0	0
D	Acres	2,366	10,230	7,864
AUM's produced	No.	919	1,541	622
Animal output value	Dollars	8,050	13,888	5,838
Employment	Manhours	824	1,389	565
Total cost	Dollars	4,300	10,107	5,807
Cost per AUM	(1)	4.68	6.56	1.88

[1] Cost/AUM is dollars only.

jobs could be created in this area, thereby reducing chronic unemployment.

Evaluation of this option is limited to the costs and results in terms of grazing and related outputs. The analysis does not evaluate the validity of this type of subsidy program versus other social programs. The example described indicates the capability to further modify the program-selection criteria of this analysis to specifically treat selected social values.

Costs, Flexibility and Cultural Heritage

The total cost of producing animal unit months under Alternative 19 was $1,043 million per year, or $3.26 per AUM. This is the highest cost of all the least-cost alternatives tested. Under Alternatives 12, 16, and 20, costs per AUM were $2.56, $2.35, and $1.66, respectively, and the required production of AUM's was approximately equal. Only in the Resource Situation—1970 at $4.03 per AUM, and the Now Policy at $4.25 per AUM were costs higher (table 25).

The higher cost as the analysis moved through Alternatives 20, 12, 16, and 19 was caused by the increased limitations placed on the analysis (fig. 53). Limitations on acreages by strategy precluded the selection of the low cost resource units for additional grazing, in order to limit the impact on the existing situation. As the restrictions became more rigid, the cost of grazing increased.

In Alternative 19, specified levels of national outputs for wood growth, water yield, quality water, and sediment production were added to the analysis. These added restrictions forced another increase in costs. Therefore, from the viewpoint of grazing production nationally, the cost of protecting the existing investment in grazing, the cost of maintaining wood and water outputs, and the cost of improving other aspects of environmental quality increases the average cost of an animal unit month by $1.60. This increase in cost of $1.60 is the difference between the average cost per AUM of $1.66 under Alternative 20 (the pure efficiency concept) and the average cost of $3.26 per AUM under Alternative 19 (constrained to insure the quantity of the other outputs).

TABLE 25.—*Total investment costs and costs per animal unit month for 1970 and selected alternatives*

Item	Total cost	Cost per AUM	AUM's produced
	Million dollars	*Dollars*	*Millions*
Resource Situation—1970	858.2	4.03	213.1
Now Policy	1,960.4	4.25	461.5
Alternatives:			
1	291.0	1.31	222.6
2	916.5	1.99	461.6
20	531.7	1.66	319.7
10	583.3	2.62	222.5
12	854.2	2.56	333.9
16	785.6	2.35	334.0
19	1,042.5	3.26	319.7

Nearly 50 percent of the cost of grazing under conditions of Alternative 19 results from the need to meet demands for outputs other than grazing from the forest-range environment. It is necessary to restate that only investments in systems of livestock and environmental management were included in this analysis. A complete understanding of the costs of the trade-offs involved could be achieved by including alternative management strategies for wood growth, water yield, and other outputs.

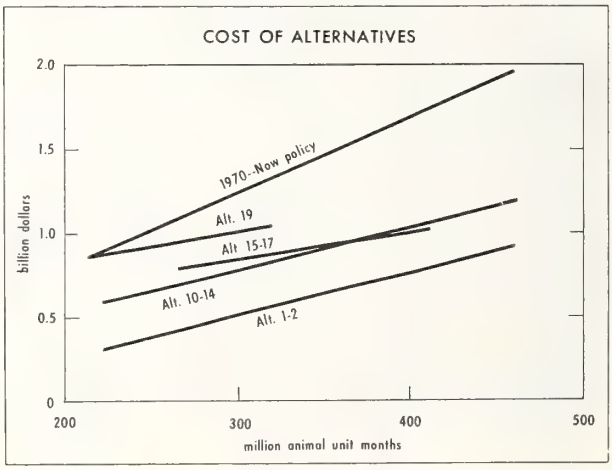

FIGURE 53.

Flexibility was another measurement included in the analysis and is relevant in connection with a discussion of costs. Flexibility remains unchanged for the total forest-range environment between the Resource Situation—1970 and Alternative 19 (table 58). This indicates that adjustments in management for new and unforeseen factors would be no more difficult under the suggested strategy combinations of Alternative 19 than they were under 1970 conditions.

Resident cultural heritage would not be changed from 1970 by the management prescribed by Alternative 19. This is understandable because the grazing of livestock, which is an important portion of cultural heritage, was retained by the constraints established (fig. 54). As would be expected, this quality deteriorated some under the conditions of Alternatives 1, 2, and 20. Nonresident cultural heritage showed no change under Alternative 19.

IMPLICATIONS TO PLANNING

Several questions were suggested in the discussion in Chapter IV, Analytical Concepts and Procedures. Answers to these questions, based on the analysis reported herein, serve to summarize the understanding of how the forest-range environment can be analyzed relative to resource capabilities, management options, and the demand for commodity and environmental quality outputs.

How can the many implications of changing demands, changing technologies, and changing policies be assessed? As demonstrated in this system, an analysis which simultaneously considers many outputs from a given resource increases the understanding of these diverse changes. For example, the changing demand for food increases the demand for beef and subsequently the demand for feed, including grazing, for cattle. The demand for grazing,

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FIGURE 54.—Livestock ranching is an important part of our cultural heritage.

however, is modified by the changing technology and structure of the beef industry and modifies the impact of demands on the forest-range environment for feed. The total impact on the resource may or may not have been modified by this changing technology when all outputs are considered. The impact of changing governmental policies was assessed by measurement of trade-offs between ecosystems if action were taken to invest in one output versus another, or to prevent Federal investment in one ecosystem versus another. The data, analytical system, and evaluation completed permits assessment of changing or projected changes in conditions as they impact on the management of the forest-range resource.

What is the most efficient way for meeting future demands for forest-range grazing under existing public policies with respect to maintaining: (1) a viable rural economy and (2) a quality environment? This question can be only partially answered at this point. It has been established that identification of the most efficient lands for grazing for added development can insure that the cost of grazing does not increase to the point that grazing becomes noncompetitive with other feed sources. Such a mix has tentatively been identified in Alternative 19. It has also been established that the further development of certain lands, while physically possible, is not efficient, and these lands should remain under the extensive management strategies. Alternative 19 also identified an output of AUM's which met projected demands while preventing deterioration of total environmental quality values.

What is the existing capability of the forest-range environment to produce grazing and associated products? Again this question is only partially answered. The capability of the forest-range environment to produce grazing is nearly eight times the projected demand in year 2000, but can be accomplished only through sacrifice of other outputs. Projected demands for grazing can be met for year 2000 without adverse impacts on other outputs through the careful selection of ecosystems and resource units to be developed for grazing. The capability of the forest-range to produce outputs other than grazing cannot be fully assessed until strategies are also developed specifically for the management of the resource for production of those outputs and this information included in the analysis.

What investment will be required to complete present policies? An additional $1,102 million annually will be required to implement present policies for the total forest-range environment by year 2000 as measured by the Now Policy alternative. Several alternatives have been evaluated which are reasonable options to the continuation of current policy direction and which can achieve the same output levels at lower costs.

What is the least-cost program of range management for achieving selected levels of associated products? Alternative 19 represents one alternative that would preclude decreases in wood growth, water yield, and quality water while grazing is increased. Added alternatives of this type are needed as are added management data on wood growth and water yield. Additional alternatives not yet formulated are necessary to complete the response to this question.

What future patterns of grazing production will be expected to prevail? It has been generally established that the future grazing pattern to be expected will increase grazing in the Eastern Forest ecogroup. Amount of range grazed in the Great Plains Ecogroup would not change appreciably but there would be increases in the intensity of management. The Western Range and Western Forest would be expected to have an AUM output at least equal to current levels but on fewer acres. The Western ecogroups would stay in the production of grazing but the magnitude of grazing will depend in part on the specific policies developed to protect existing investment and established rural communities.

Can range management offset such environmental attributes as rare and endangered species? Without question improvement or degradation of these and many other environmental attributes is possible through the kind of range management systems used. Not fully resolved at this point is the full scope of the trade-offs involved and further assessment must be developed to determine which of the attributes can be improved simultaneously and the impact on production costs.

What are the costs and output implications of managing all of the forest-range environment under a single management strategy? Single strategy management had adverse effects on the environmental attributes and is the most expensive means of achieving AUM output when reqirements are above 200 million. Single, simple broad strategy applications are incapable of meeting demands at reasonable costs.

What is the impact of increases in demand for outputs of the forest-range environment? The increased demands require new approaches to the selection of management strategies. If the increasing demands are to be met at reasonable costs, then analytical systems with efficiency criteria and capabilities to deal simultaneously with several to many sets of demands and resource values should be used to select the best management. Selection of least cost combinations of management strategies by ecosystem and resource units consistently lowers the costs and permits improvement in other (non-graz-

ing) outputs. Anticipated changes in demand and technology require new policies. This is especially true of the Federal agencies because they have multiple use responsibilities which make policy development increasingly difficult and probably will require new planning procedures.

SUMMARY

Given the projected demand for livestock feeds, the forest-range environment, through carefully designated management, can be expected to continue to provide a part of the total livestock feed requirements. This was indicated by the capability of the forest-range environment to produce the projected grazing demands for the year 2000 at a cost not in excess of the Resource Situation—1970 cost per AUM, and without adverse impacts on the accompanying outputs.

This analysis has established that grazing of the forest-range environment does have important impacts on the other outputs; but grazing management (combinations of strategies) can be developed which will enhance environmental quality at competitive costs.

From the viewpoint of national demands and considering investment costs, a changing geographic emphasis on production will be required. In the traditional grazing areas of the West, particularly those lands in low productivity classes and in poor condition in 1970, the cost of maintaining grazing and improving the output of environmental qualities is high. Therefore, there should be a reassessment of the levels and management direction for use of such lands for domestic grazing. On areas where productivity potential is high, an opportunity exists to intensify the management. The intensive management of these areas not only will improve the quantity of environmental quality outputs, but will serve to maintain the livestock production level in many areas, and minimize the impact of reduced grazing on selected other lands.

The great bulk of the forest-range environment is in non-Federal ownership. The major impacts of grazing on environmental quality will depend on how the non-Federal sector manages its lands simply because that sector controls most of the land. If national demands for all of the outputs discussed herein are to be achieved, then the non-Federal sector must contribute more effectively. The management levels suggested in Alternative 19 call for intensive management of many ecosystems, especially in the Eastern Forest ecogroup where considerable exploitative grazing now exists.

The acreage of the forest-range environment administered by the Federal agencies is smaller than the non-Federal sector, but generally has unique characteristics. Because of these unique characteristics, the Federal agencies have major opportunities to have impact on selected environmental outputs through the management of grazing. Federal agencies administer those lands which, because of their physical characteristics, are major sources of sediment in streams. A revised selection of management strategies would serve to reduce this problem.

There is an opportunity suggested to bring National Forest System lands of the Eastern Forest ecogroup into grazing production. Bringing these lands into grazing use under the strategies suggested in Alternative 19 would decrease the grazing pressure on some of the more fragile lands and make them available for such uses as non-game birds, rare species, and certain types of recreation.

It would have been helpful in this study to relate grazing demand to the changes in national demands for the other outputs (environmental) and the ability of the forest-range to meet those projected needs. Such opportunities are beyond the limits of the data. It is possible, however, to conclude that grazing of the Nation's forest-range environment is compatible with the increasing demands for livestock feed, and that these increases can be achieved on a national basis, and without reduction in environmental quality.

APPEXDIX A—1970 FRES ECOSYSTEMS

This appendix contains a brief description of the vegetation of each FRES ecosystem. Also shown for each ecosystem are the associated Küchler's plant communities, rare and endangered species, and the percent of the ecosystem that is economically depressed.[1] The Küchler communities included within each ecosystem are identified by Küchler's number and name (i.e., K-86 Great Lakes pine forest).[2]

The ecosystems are presented in four Ecogroups. These are: Western Range, Western Forest, Great Plains, and Eastern Forest.

Detailed descriptions of the Ecosystems are presented in a companion publication. (See inside front cover for reference.)

WESTERN RANGE

SAGEBRUSH

Vegetation

The Sagebrush ecosystem is characterized by shrubs, principally sagebrush, which are usually 1 to 7 feet high. Other shrubs are part of the vegetation composition. Grasses such as the wheatgrasses, fescues, bluegrasses, and bromegrasses as well as broadleaved herbs are found in the understory.

Küchler Communities

K-32 Great Basin sagebrush
K-49 Sagebrush steppe
K-50 Wheatgrass-needlegrass shrubsteppe

Rare and Endangered Species

Utah prairie dog
Tule elk
Mexican duck

Area Economically Depressed

25 percent

DESERT SHRUB

Vegetation

The vegetation is characterized by xeric shrubs varying in height from four inches to many feet. Stands are generally open with a large amount of bare soil and desert pavement exposed. However, some stands may be relatively dense. Understory vegetation is generally sparse. During years of above average rainfall, annuals may be conspicuous for a short period of the year. Production varies greatly from year to year depending on the moisture supply.

Küchler Communities

K-23 Mesquite bosques
K-33 Blackbrush
K-34 Saltbush-greasewood
K-35 Creosote bush
K-36 Creosote bush-bur sage
K-37 Palo verde-cactus shrub

Rare and Endangered Species

Tule elk
Yuma clapper rail
Masked bobwhite
California condor

Area Economically Depressed

10 percent

SOUTHWESTERN SHRUBSTEPPE

Vegetation

The Southwestern shrubsteppe ecosystem characterizes vegetation types ranging from short grass with scattered shrubs to shrubs with scattered areas with short grasses. This is due to relatively long transition from this ecosystem to the more woody pinyon-juniper and/or desert shrub ecosystems. Yucca is one of the most characteristic woody species; mesquite is abundant in many areas. Creosote and tarbush dominate the shrub layer. Black grama, three-awns, and tobosa dominate the herbaceous layer. Sideoats grama and curly mesquite are also important. The shrub-grass stands occupy shallow soils with little development. The grass-shrub stands occupy the soils with more development.

Küchler Communities

K-52 Grama-tobosa shrubsteppe
K-53 Trans-Pecos shrub savanna

Rare and Endangered Species

Masked bobwhite

[1] FRES "Economically Depressed Areas" are "EDA Qualified Areas" as defined by the U.S. Dept. of Commerce, Economic Development Administration. 1969.

[2] Number and names are those assigned by A. W. Küchler. 1970. The National Atlas of the United States. United States Department of Interior, pp. 89–91.

Area Economically Depressed

10 percent

CHAPARRAL-MOUNTAIN SHRUB

Vegetation

The vegetation of the ecosystem consists of dense to open brush or low trees. Deciduous, semideciduous, and evergreen species are represented in the types. Some of the brush types are so dense that understory vegetation is practically eliminated while other types support a highly productive understory. Recent activities of man have altered the types to a degree that reconstruction of their original state would be difficult.

Küchler Communities

K-27 Oak-juniper woodland
K-28 Transition between oak-juniper woodlands (K-27) and Mountain mahogany-oak scrub (K-31)
K-29 Chaparral
K-30 Coastal sagebrush
K-31 Mountain mahogany-oak scrub

Rare and Endangered Species

Light-footed clapper rail

Area Economically Depressed

35 percent

PINYON-JUNIPER

Vegetation

The name "pygmy forest" characterizes the pinyon-juniper woodlands. The trees occur as dense to open woodland and savanna woodland. Trees may grow to a height of 30 feet but are generally less than 15 feet. The form of the tree is bushy, being almost as wide as it is tall.

Küchler Communities

K-21 Juniper-pinyon woodland

Area Economically Depressed

65 percent

MOUNTAIN GRASSLANDS

Vegetation

Although mountain grasslands range from foothills at northerly latitudes to high mountain sites, they are characterized by bunchgrasses such as the fescues and wheatgrasses. Productivity classes are related to total precipitation, the abundance of precipitation during the growing season, and soil factors. Desirable forbs are abundant on some of the more productive sites.

Küchler Communities

K-40 Fescue-oatgrass
K-43 Fescue-wheatgrass
K-44 Wheatgrass-bluegrass
K-46 Fescue-mountain muhly prairie
K-56 Foothills prairie

Rare and Endangered Species

Utah prairie dog

Area Economically Depressed

10 percent

MOUNTAIN MEADOWS

Vegetation

Grasses, sedges, rushes, and in some cases phreatophytic shrubs dominate the meadow. In best condition 70 percent of the ground is covered by vegetation; more than three-fourths of this may be perennial grasses. Sedges may constitute as much as 15 percent of the cover. Perennial forbs constitute only about 10 percent of the cover. Proportions of the various growth forms are easily manipulated by grazing pressure.

Küchler Communities

(Not recognized by Küchler; included in FRES because of their significance to range management.)

Rare and Endangered Species

Utah prairie dog

Area Economically Depressed

10 percent

DESERT GRASSLANDS

Vegetation

A grass life form predominates on these plateaus between dominant shrub life forms above and below this ecosystem. Transition zones show shrubs giving way to galleta in the southern extensions of this ecosystem in Texas and three awn becomes the dominant in the northern extensions in Utah. This ecosystem is also a more open grassland with low shrubs in the northern extensions.

Küchler Communities

K-47 Grama-galleta steppe
K-48 Grama-tobosa prairie
K-51 Galleta-three awn shrubsteppe

Rare and Endangered Species

Sonoran pronghorn

Area Economically Depressed

20 percent

ANNUAL GRASSLANDS

Vegetation

The vegetation is of grass life form. Annual grasses (most are considered introduced) now dominate the cover. The dominant species are: wild oats, several species of brome, wild barley, and fescue. Perennials are scarce or absent at

lower elevations and increase at the upper elevations of the ecosystem. Forbs, with the exception of filaree, are of secondary importance but the number occurring is large. Many people believe the prehistoric vegetation was perennial but historical evidence is meager and reconstruction of the original perennial vegetation (if it were perennial), if it can be done at all, is accomplished only with complete protection and considerable effort. The earliest references (early 1800's) indicate the California steppe was dominated by annual grasses. The annual plant type, as might be expected, has shown probably the most consistent and profitable response to range fertilization practices of any range type.

Küchler Communities

K-41 California steppe

Rare and Endangered Species

San Joaquin kit fox
Tule elk

Area Economically Depressed

50 percent

ALPINE

Vegetation

The grass life form predominates, but the number of subdominant forbs is very large. Willows may occur on the moist soils of protected slopes and valleys.

Küchler Communities

K-45 Alpine meadows and barren

Rare and Endangered Species

Grizzly bear

Area Economically Depressed

5 percent

WESTERN FOREST

DOUGLAS-FIR

Vegetation

Commercial Douglas-fir stands are defined as those containing 50 percent or more Douglas-fir, except where redwood, sugar pine, or western white pine comprise 20 percent or more of the stand. Most common ecological descriptions define Douglas-fir timber in western Oregon and Washington define it as subclimax stands within the climax western hemlock-western red cedar formation. Common shrubs in the stands are species of maple, rock-spirea, filbert, blueberry, snowberry, barberry, currant, blackberry, ninebark, rose and spirea. Grass or grass-like growth form is more apparent in the stands of interior states. Here, pinegrass and sedge are present.

Küchler Communities

K-2 Cedar-hemlock-Douglas-fir forest
K-11 Douglas-fir forest
K-24 Mosaic cedar-hemlock-Douglas-fir forest (K-2) and Oregon oakwoods (K-22)
K-25 California mixed evergreen forest

Rare and Endangered Species

Columbian white-tailed deer
Grizzly bear

Area Economically Depressed

10 percent

PONDEROSA PINE

Vegetation

By definition ponderosa pine forest is 50 percent or more of one of the pines—ponderosa pine, Jeffrey pine, sugar pine, limber pine, Arizona ponderosa pine, Apache pine, or Chihuahua pine. The exceptions are those situations where western white pine or sugar pine are predominant; these species then control the name of the ecosystem. The impact of logging and ecological dynamics can cause some problems in maintaining good delineation of this ecosystem. The ponderosa pine unit is idealized as open and park-like with excellent ground cover of grasses, sedges, and forbs, or with an understory of shrubs of low to medium height. The shrubs, however, may vary in from from antelope bitterbrush (three to five or six feet tall) to bearmat (ground-hugging).

Küchler Communities

K-5 Mixed conifer forest
K-9 Pine-cypress forest
K-10 Western ponderosa forest
K-15 Eastern ponderosa forest
K-16 Black Hills pine forest
K-17 Pine-Douglas-fir forest
K-18 Arizona pine forest

Rare and Endangered Species

Kaibab squirrel
Grizzly bear
California bighorn
California condor

Area Economically Depressed

60 percent

WESTERN WHITE PINE

Vegetation

Forests in which 20 percent or more of the stand is western white pine or sugar pine characterize this ecosystem.

Küchler Communities

K-12 Cedar-hemlock-pine forest

Rare and Endangered Species

Grizzly bear
California bighorn

Area Economically Depressed

90 percent

FIR-SPRUCE

Vegetation

The Fir-spruce ecosystem is characterized by open to dense forest of low to tall needleleaf evergreen trees with patches of shrubby undergrowth and scattered herbs. Fifty percent or more of the stand is silver fir, subalpine fir, red fir, white fir, mountain hemlock, Engelmann spruce, or blue spruce, singly or in combination, except where western white pine comprises 20 percent or more, in which case the ecosystem would be classified as white pine.

Küchler Communities

K-3 Silver fir-Douglas-fir forest
K-4 Fir-hemlock forest
K-7 Red fir forest
K-14 Western spruce-fir forest
K-19 Spruce-fir-Douglas-fir forest
K-20 Southwestern spruce-fir forest

Rare and Endangered Species

Grizzly bear
California bighorn

Area Economically Depressed

70 percent

HEMLOCK-SITKA SPRUCE

Vegetation

This ecosystem is defined as 50 percent or more of the forest stand being in western hemlock and/or Sitka spruce. Other tree species which may be present to a lesser degree are Douglas-fir, grand fir, and western redcedar. Some of the most common shrubs are vine maple, red whortleberry, Cascades mahonia, California dewberry, and coast rhododendron. Usual herbs are American twinflower, hollyfern, gold thread and redwood violet.

Küchler Communities

K-1 Spruce-cedar-hemlock forest

Rare and Endangered Species

Glacier bear
Grizzly bear

Area Economically Depressed

20 percent

LARCH

Vegetation

Larch forests are commercially defined as those in which 50 percent or more of the stand is larch except where western white pine comprises 20 percent or more of the timber volume.

Ecologically, larch is considered seral to stands of grand fir and stands of Douglas-fir. This dense type produces 75 to 150 pounds of understory herbage per acre. However, where it is patch clearcut, planted to trees, and seeded to grass, it will produce 2,000 to 3,000 pounds of herbage per acre for 10 to 15 years. Understory species are commonly of the same genera as found in spruce-fir stands and some of the Douglas-fir stands.

Küchler Communities

K-13 Grand fir-Douglas-fir forest

Area Economically Depressed

20 percent

LODGEPOLE PINE

Vegetation

Lodgepole pine forests are commercially defined as stands with 50 percent or more lodgepole pine. Ecologically, they are seral to some of the western interior coniferous forests. "Doghair" stands (i.e.—many stems per acre) often develop after fires. Understory species, if present, are of about the same genera as found in stands of interior Douglas-fir, larch, and spruce-fir. Herbage production can be 0 to 50 pounds per acre in dense stands or 2,000 to 3,000 pounds per acre where clearcuts, burns, or stand conversions to a different coniferous stand are carried out. Of course, the productivity declines with time and in 10 to 20 years will return to a very low production status.

Küchler Communities

K-8 Lodgepole pine-subalpine forest

Rare and Endangered Species

California bighorn
California condor

Area Economically Depressed

35 percent

REDWOOD

Vegetation

The vegetation is a dense forest of very tall evergreen, needleleaf trees, sometimes with much undergrowth. Twenty percent or more of the stand is redwood. The dominant plants are redwood and Douglas-fir. Other major components of the vegetation include grand fir, salal, Pacific waxmyrtle, coast rhododendron, western hemlock, and box blueberry.

Küchler Communities

K-6 Redwood forest

Rare and Endangered Species

California condor

Area Economically Depressed

100 percent

HARDWOODS

Vegetation

The portions of the western hardwoods within continental United States include forests in which 50 percent or more of the stand is hardwood species, except where western white pine, sugar pine, or redwood comprise 20 percent or more in which case the ecosystem would be classified as white pine or redwood. The vegetation is a forest of low to medium tall broadleaf deciduous or evergreen trees, sometimes with an admixture of low to medium tall needleleaf evergreens, often with an understory of grass and shrubs. In the California and Oregon portions dominant species include Oregon white oak, Coulter pine, digger pine, coast live oak, canyon live oak, blue oak, valley oak, and interior live oak. In California this ecosystem lies mainly between the annual grasslands and the chaparral and mixed conifer zones. The portion in the widely scattered Rocky Mountain and plains states is primarily quaking aspen stands with a highly variable understory of grasses, forbs, and shrubs. In many areas where the aspen stands are inclusions within sagebrush or conifer types, they are very important sources of food and cover for various wildlife species. Cottonwood becomes dominant on plains, more or less replacing aspen.

Küchler Communities

K-22 Oregon oakwoods
K-26 California oakwoods
K-7 Red fir forest (seral stage)
K-11 Douglas-fir forests (seral stages)
K-13 Grand fir-Douglas-fir forests (seral stages)
K-14 Western spruce-fir forest (seral stage)
K-19 Spruce-fir-Douglas-fir forest (seral stages)
K-20 Southwestern spruce-fir forest (seral stages)

Rare and Endangered Species

San Joaquin kit fox
Tule elk

Area Economically Depressed

20 percent

GREAT PLAINS

SHINNERY

Vegetation

Shinnery vegetation is a midgrass prairie with open to dense stands of broadleaf deciduous shrubs and occasional needleleaf low trees and shrubs. The major shrub species are shin oak, Havard's oak, redberry juniper, and mesquite. Little bluestem and side-oats grama are the most common grass species. Sand bluestem is sometimes locally common. Sandsage and small soapweed are the most common forbs (low shrubs).

Küchler Communities

K-64 Shinnery

Rare and Endangered Species

Lesser prairie chicken

Area Economically Depressed

5 percent

TEXAS SAVANNA

Vegetation

This is a high-shrub savanna ecosystem with a dense to very open community of broadleaf, deciduous and evergreen low trees and shrubs and needleleaf, evergreen low trees and shrubs. The grass varies from short to medium and the herbaceous vegetation varies from dense to open. Mesquite is the most widespread woody plant. Others are acacia, oaks, juniper, and ceniza along the Rio Grande valley and bluffs. Species of prickly pear cactus are widespread. The herbaceous plants are mainly such grasses as bluestems, three awn species, buffalograss, gramas, and curly mesquite and tobosa on the Edwards Plateau.

Küchler Communities

K-38 Ceniza shrub
K-54 Mesquite-acacia savanna
K-55 Mesquite-liveoak savanna
K-77 Juniper-oak savanna
K-78 Mesquite-oak savanna

Area Economically Depressed

40 percent

PLAINS GRASSLANDS

Vegetation

Grasses with low stature and warm season growth predominate with a minor interspersion of forbs and shrubs. Vast stretches of this ecosystem are dominated almost exclusively by blue grama, with buffalo grass as a companion in many areas. However, the eastern half of the north half of this ecosystem is dominated by western wheatgrass and needlegrass. The occasional shrubs include juniper, silver sagebrush, silver buffaloberry, and skunkbush sumac in the northern reaches and rabbit brush and mesquite in the southern part. Forbs are generally quite common, but many are ephemerals.

Küchler Communities

K-57 Grama-needlegrass-wheatgrass
K-58 Grama-buffalo grass
K-59 Wheatgrass-needlegrass
K-60 Wheatgrass-bluestem-needlegrass
K-61 Wheatgrass-grama-buffalo grass

K-62 Bluestem-grama prairie
K-76 Mesquite-buffalo grass

Rare and Endangered Species

Black-footed ferret
Northern greater prairie chicken
Lesser prairie chicken

Area Economically Depressed

10 percent

PRAIRIE

Vegetation

The prairie ecosystem is known to many as the tall grass or true prairie with the bluestems constituting about 70 percent of the vegetation and reaching heights of 5 to 6 feet. Large numbers of flowering forbs also exist but are usually over-shadowed by the grasses. Most of the plants are classified as warm-season plants. Woody vegetation is rare with willow occasionally occurring on the exceptionally moist areas of the northern part of the ecosystem and needleleaf evergreens and broadleaf deciduous trees scattered in the southern part.

Küchler Communities

K-63 Sandsage-bluestem prairie
K-66 Bluestem prairie
K-67 Nebraska sandhills prairie
K-68 Blackland prairie
K-69 Bluestem-sacahuiste prairie
K-74 Cedar glades
K-79 Fayette prairie

Rare and Endangered Species

Black-footed ferret
Northern greater prairie chicken
Lesser prairie chicken
Attwater's greater prairie chicken
Whooping crane

Area Economically Depressed

5 percent

EASTERN FOREST

WHITE-RED-JACK PINE

Vegetation

Forest in which 50 percent or more of the stand is eastern white pine, red pine, or jack pine, singly or in combination, represents the white-red-jack pine ecosystem. Common associates includes oaks, eastern hemlock, aspen, birch, northern white cedar, and maple.

Küchler Communities

K-86 Great Lakes pine forest

Rare and Endangered Species

Eastern timber wolf
Kirtland's warbler

Area Economically Depressed

60 percent

SPRUCE-FIR

Vegetation

Forests in which 50 percent or more of the stand is spruce or true fir, singly or in combination, characterize this ecosystem. Common associates include northern white cedar, tamarack, maple, birch, and eastern hemlock.

Küchler Communities

K-84 Great Lakes spruce-fir forest
K-85 Conifer bog
K-87 Northeastern spruce-fir forest
K-88 Southeastern spruce-fir forest

Rare and Endangered Species

Eastern timber wolf
Glacier bear
Grizzly bear

Area Economically Depressed

25 percent

LONGLEAF-SLASHPINE

Vegetation

Forests in which 50 percent or more of the stand is longleaf pine or slashpine, singly or in combination, characterize this ecosystem. Common associates include other southern pines, oaks, and gum.

On most sites, grasses either dominate the understory or share dominance with shrubby forms. East of the Apalachicola River, wiregrasses are the main herbaceous species, whereas bluestems provide most of the herbage in the western section. Other important grasses include panicgrass, paspalums, and dropseeds. Gallberry, saw-palmetto, wax-myrtle, and shining sumac are prominent among the shrubs.

Küchler Communities

K-102 Southern mixed forest (seral stages)
K-106 Subtropic pine forest (So. Florida)

Rare and Endangered Species

Southern bald eagle
Northern red cockaded woodpecker
Southern red cockaded woodpecker
Dusky seaside sparrow
Cape Sable sparrow

Area Economically Depressed

40 percent

LOBLOLLY-SHORTLEAF PINE

Vegetation

This ecosystem is characterized by forests in which 50 percent or more of the stand is loblolly pine, shortleaf pine, or other southern

yellow pines, singly or in combination. Common associates include oaks, hickory, sweet gum, black gum, red maple, and winged elm. The main grasses are bluestems, panicums, and longleaf uniola. Dogwood, biburnums, haws, blueberries, American beauty berry, yaupon, and numerous woody vines are common in the understory.

Küchler Communities

K-100 Northeastern oak-pine forest
K-101 Oak-hickory-pine forest
K-104 Pocosin
K-105 Sandpine scrub

Rare and Endangered Species

Delmarva Peninsula fox squirrel
Southern bald eagle
Northern red cockaded woodpecker

Area Economically Depressed

35 percent

OAK-PINE

Vegetation

Forests in which 50 percent or more of the stand is hardwoods, usually upland oaks, but in which southern pines, mainly shortleaf pine, make up 25-49 percent of the stand characterize this ecosystem. Common associates include gum, hickory, and yellow-poplar. Productivity of the understory is relatively low, ranging from 50 to 500 pounds of herbage per acre per year.

Küchler Communities

K-101 Oak-hickory-pine forest
K-102 Southern mixed forest

Rare and Endangered Species

Northern red cockaded woodpecker
Bachman's warbler

Area Economically Depressed

30 percent

OAK-HICKORY

Vegetation

Four major vegetation types characterize the Oak-hickory ecosystem; they are the sweetgum-oak-juniper type of the blackbelt and the Coastal Plain in Alabama and Mississippi, the oak-hickory and oak-hickory-bluestem types of the Ozark-Boston Mountains and Interior low plateaus and their extensions, and the oak forest of the Appalachians. The major life form is a tree community varying from open to closed woods with a strong to weak understory of shrubs, vines, and herbaceous plants. Oak and hickory must make up 50 percent of the stand, singly or in combination, to make it an oak-hickory ecosystem. However, if southern pines make up 25-49 percent of the stand, it is then an oak-pine ecosystem. Sweetgum and redcedar are close associates in the southern (blackbelt) region of the Oak-hickory ecosystem. Maple, elm, yellow poplar, and black walnut often are close associates in eastern and northern parts of the oak forest and oak-hickory-bluestem types. The major shrub species are blueberry, viburnum, dogwood, rhododendron, and sumac. The major vine species are woodbine, grape, poison ivy, greenbrier, and blackberry. Important herbaceous plants are sedges, panicums, bluestem, lespedeza, tickclovers, goldenrod, pussytoes, aster, and many more which can be locally abundant.

Küchler Communities

K-72 Oak savanna
K-73 Mosaic of bluestem prairie (K-66)
K-75 Cross timbers
K-80 Blackbelt
K-91 Oak-hickory forest
K-95 Appalachian oak forest

Rare and Endangered Species

Southern bald eagle
Bachman's warbler

Area Economically Depressed

30 percent

OAK-GUM-CYPRESS

Vegetation

The vegetation of this ecosystem varies considerably but the dominants are of tree life-form. It is made up of bottom-land forests in which 50 percent or more of the stand is tupelo, black gum, sweetgum, oaks, and bald cypress, singly or in combination, except where pines comprise 25-49 percent, in which case the ecosystem would be classified as oak-pine. Common associates include willow, maple, sycamore, cottonwood, and beech. Most species are broadleaf deciduous trees. Trees of the mangrove swamp are mainly black and red mangrove. The vegetation of the cypress savanna is dominated by needleleaf deciduous trees and some broadleaf, evergreen, or deciduous trees and shrubs. The trees and shrubs occur in groves surrounded by open grassland dominated mainly by three awn species. Mangrove swamps are often flooded by tide (salt) water while the cypress savanna is flooded less frequently and only by fresh water.

Küchler Communities

K-81 Liveoak-sea oats
K-82 Cypress savanna
K-96 Mangrove
K-102 Southern floodplain forest

Rare and Endangered Species

Florida panther
Southern bald eagle

Dusky seaside sparrow
Cape Sable sparrow
Florida Everglades kite (Florida snail kite)
Bachman's warbler

Area Economically Depressed

80 percent

ELM-ASH-COTTONWOOD

Vegetation

The vegetation of this ecosystem is a tree life form of low to tall broadleaf deciduous trees, open to dense often with vines. Cottonwood species usually dominate and often in pure stands. Cottonwood is the most common along the streams and swamp cottonwood more common other places. Common associates in the northern region are willow species and green and white ash while sycamore and sugarberry are common associates in the southern region. According to Forest Survey definition, a forest becomes this type when 50 percent or more of the stand is elm, ash, or cottonwood, singly or in combinations. Common associates can be willow, sycamore, beech, and maple. The cottonwood-willow stage is short lived and the stage passes to the river birch, silver maple-American elm types in the north and to the sycamore-pecan-American elm or sugarberry-American elm-green ash types in the southern part of this ecosystem.

Küchler Communities

K-89 Northern floodplain forest
K-92 Elm-ash forest

Area Economically Depressed

10 percent

MAPLE-BEECH-BIRCH

Vegetation

A forest is classified (according to Forest Survey definitions) as this ecosystem when 50 percent or more of the stand is maple, beech, or yellow birch, singly or in combination. Common associates include hemlock, elm, basswood, and white pine.

Küchler Communities

K-90 Maple-basswood forest
K-93 Beech-maple forest
K-94 Mixed mesophytic forest
K-97 Northern hardwoods
K-98 Northern hardwoods-fir forest
K-99 Northern hardwoods-spruce forest

Rare and Endangered Species

Eastern timber wolf

Area Economically Depressed

25 percent

ASPEN-BIRCH

Vegetation

This ecosystem is commercially defined as forest in which 50 percent or more of the stand is aspen, balsam poplar, paper birch, or gray birch, singly or in combination. Common associates include maple and balsam fir. Geographically this ecosystem occurs mostly in the area of the Great Lakes from western Minnesota to Lake Erie in the United States. Aspen, however, extends from the Arctic Circle in Alaska southeastward to the northeastern United States. Major aspen species in the Great Lakes area are bigtooth aspen and quaking aspen. Paper birch is a common associate in the ecosystem. Balsam poplar is important only along streams and swamp margins.

Küchler Communities

K-97 Northern hardwoods (seral stages)
K-98 Northern hardwoods-fir forest (seral stages)
K-99 Northern hardwoods-spruce forest (seral stages)

Rare and Endangered Species

Eastern timber wolf

Area Economically Depressed

65 percent

WET GRASSLANDS

Vegetation

The coastal prairies (marshes) are occupied by cordgrasses—smooth cordgrass and salt-meadow cordgrass (with the latter more prevalent on the Atlantic Coast—saltgrass, and a few forbs. The vegetation forms a medium tall to very tall grassland, usually dense. The palmetto prairie and Everglades are dense, medium tall to tall grasslands with scattered palms and shrubs in the palmetto prairie and with scattered low to medium tall broadleaf evergreen trees and shrubs in the Everglades. The major species in the palmetto prairie are pineland three awn and saw-palmetto. The major species of the Everglades grassland are sawgrass and wiregrasses. The vegetation of the tule marshes is a tall graminoid vegetation consisting of various species of tules and bulrushes, cattail, and soft flag. Several species of sedges occur less commonly.

Küchler Communities

K-42 Tule marches
K-65 Northern cordgrass prairie
K-70 Southern cordgrass prairie
K-71 Palmetto prairie
K-83 Everglades

Rare and Endangered Species

Texas red wolf
Florida panther
Key deer
Tule elk
Florida great white heron
Florida sandhill crane
California clapper rail
California black rail
Tule white-fronted goose
California condor
Attwater's greater prairie chicken
Whooping crane
Florida Everglades kite (Florida snail kite)

Area Economically Depressed

75 percent

APPENDIX B—COST RATIONALE

This appendix contains the rationale used to develop investment costs for practices used in each ecosystem. It also shows the investment costs for a sample resource unit, as well as the practice life expectancy and maintenance costs for all ecosystems (tables 26, 27, 28).

Skilled labor, as used in the cost data, includes anyone having special training or skills. A chain saw operator, truck driver, or tractor operator would all be considered skilled labor. Unskilled labor includes hand laborers such as swampers, men to dig post holes, to build fences, and for similar work.

The basic rationale for cost data by practice was as follows:

1. Fertilization.—The per acre cost of fertilization for each ecosystem was based on the pounds of nutrients applied to the soil. This varied by ecosystems and in some cases by productivity classes within the ecosystem. In some instances the practice was applied more than once annually. In these cases, the cost was multiplied by the number of times fertilizer was applied in one year to bring it up to an annual basis.

2. Irrigation.—The cost for irrigation is for the system and its installation; it does not include the annual water cost or the maintenance of the system. In most of the ecosystems, the cost of irrigation increases with the decrease in productivity class because the poorer soils would require lined ditches, sprinkler systems, or some other specialized irrigation system. In the sandier, rocky type soils the cost of irrigation would be extremely high due to the special materials and equipment necessary to apply this practice. An annual maintenance and repair cost is included each year for this practice.

3. Drainage.—In some ecosystems, including Sagebrush or Plains grasslands, areas that flood intermittently could be considered for drainage. The draining of this type of area would be classified as a mechanical soil treatment practice. Drainage cost was shown only for those ecosystems that have boggy wet areas. Costs included annual maintenance and repairs. The cost of drainage varied depending on soil and terrain; costs were higher per acre on the rockier or tighter soils than on the more workable type soils.

4. Brush Control—Mechanical.—All types of mechanical brush control treatments that could be used on an ecosystem were considered in determining the per acre cost. Greater weight was given to those treatments commonly used in the particular ecosystem being evaluated. Costs varied between ecosystems and productivity classes because of soil conditions and the number of stems per acre. The costs were derived from a weighted average of the different methods of mechanical control for each ecosystem.

5. Brush Control—Chemical.—A weighted average of cost figures for different chemical treatments and different methods of applying the chemicals was used to derive a cost figure for each ecosystem. In most instances there was no difference between productivity classes since the chemical is normally not affected by soil or moisture conditions. The cost did vary from ecosystem to ecosystem. This variance was due to change in rate of application or cost of herbicide. For example, the rate of herbicide for controlling some brush species is ¼ to ½ pound of 2,4-D per acre, whereas in others the application would be from 2 to 3 pounds per acre. This would make the difference in cost between the two ecosystems to which the practices apply.

6. Brush Control—Biological.—The use of biological brush control is still in the experimental stages and has not been perfected for field use. This practice has been used only on a small scale and cost data are not available, with the exception of one ecosystem where beetles have been used to control St. Johnswort.

7. Brush Control—Fire.—For this practice three types of fire treatment were considered in the cost figures: (1) the broadcast burning of mature stands, (2) the burning of grasslands to kill invading plants, and (3) the burning of individual plants where needed if vegetation is not dense enough to carry fire. The more productive sites in most ecosystems had better cover and more dense plant growth than did the less productive classes; therefore, more precautions would be needed to control fire where it is used as a treatment. On the lower productivity classes the vegetation growth would be more

sparse, and it would be more difficult to get a fire to burn; the cost, therefore, would be about the same on most ecosystems regardless of productivity class.

8. Debris Disposal.—The cost of debris disposal is related directly to density of stand, age class, or soil conditions.

Debris disposal in all timber types is higher than for brush disposal in other ecosystems because of the larger amount of debris, which in some cases include logging slash.

9. Undesirable Forb Control.—The majority of the undesirable forb control would consist of spot treatment of small areas to control poisonous plants and noxious weeds. A great deal of this work would be done by hand or with vehicle-mounted sprayers. This would increase the cost of treatment above that given for chemical brush control. Cost figures vary between ecosystems, primarily due to accessibility and the cost of chemicals needed to control certain plant species.

10. Mechanical Soil Treatment.—The cost of mechanical soil treatment varies with productivity class and ecosystem, depending on soil type and terrain. Rocky sites or soils of fine texture would increase the cost of mechanical soil treatment. Where mechanical soil treatment is used to prepare seedbeds, a more thorough job would have to be done on the lower productivity sites, thus increasing the cost.

11. Seeding.—Seeding costs vary by ecosystem, productivity class, and in some instances between condition classes. The lower productivity classes with less precipitation in a more severe site would require a better job of seeding and may require higher priced seed or different seeding rates. An example would be in a high productivity class where broadcast seeding could be used, compared to a low productivity class where drilling on a prepared seedbed would be required. Costs between ecosystems vary primarily due to cost of seed which varies with availability of species. Seeding costs were derived through weighted averages of practices used in the different areas.

12. Prescribed Burn for Forage Improvement.—The higher productivity classes have more vegetation and require more firelines and equipment. The less productive sites, because of more scattered vegetation, would be more difficult to burn. These are offsetting costs; therefore, the same cost figures were used for all productivity and condition classes for most of the ecosystems. The cost figure is the weighted average of projects for which recent cost data were available.

13. Rodent Control.—The use of poison baits has been the most widely used method of controlling rodents. For most ecosystems the cost of this practice did not vary between productivity classes or condition classes. Most of the cost information for this practice was derived from the U.S. Fish and Wildlife Service.

14. Insect and Disease Control.—There is very little information at the present time concerning range plant diseases. Plant physiologists have not identified the diseases or assessed their effects upon range plant welfare. There is good information, however, on rangeland insects which was obtained from the Agricultural Research Service. The Task Force used an average cost figure for the control of grasshoppers and grass bugs on National Forest Systems lands. It was decided that productivity class or condition class would have little bearing on the cost of this practice for the different ecosystems.

15. Small Water Developments.—The cost figures on this item are weighted averages of different types of water developments for the different regions in the particular ecosystem for which cost data were being derived. The advance in cost from the high productivity to the low productivity classes in the different ecosystems is caused by differences in precipitation, soil, and availability of water. This same rationale would hold for the different ecosystems: the more arid the ecosystem, the more elaborate and larger the water systems needed. In the less productive sites, water sources would be more scarce, precipitation lower; therefore, in establishing such systems as trick tanks, a large apron and stronger capacity would be needed. Condition classes would have no effect on development costs. Costs for this practice also include annual repair and maintenance expenditure.

16. Large Water Developments. — The same rationale used in Item 15, Small Water Developments, would hold true for the large water developments. Actual field cost data were used for water developments. It was found that all cost data for larger water developments were very similar. Costs for this practice also include annual repair and maintenance expenditure.

17. Fences.—Considerable cost data were available for determining the fencing costs for the different ecosystems. Cost figures for fence construction are weighted averages for the fences constructed in the particular ecosystem for the different regions represented in the ecosystem. The rationale for increasing the costs of fence construction in the lower productivity classes is mainly due to differences in soil conditions and topography. In the lower productivity classes, soils gen-

erally were shallower or rocky with a slightly rougher topography. The type of fence construction required for an ecosystem was also considered; for example, let-down or log type fences in the heavier snow areas compared to the barbed wire steel post type fences in the plains. Cost for this practice also include annual repairs and maintenance.

18. Timber Thinning.—This practice applied only to forest ecosystems and was not used in any other ecosystem. The cost of timber thinning consisted of that cost above normal silvicultural practices directed specifically toward better forage production.

TABLE 26.—*Investment costs for a sample resource unit* [1]

[Where no information is shown, costs were not determined]

Practice	Unit	Labor		Equipment and materials	Total costs[2]
		Skilled	Unskilled		
		Per unit	*Per unit*	*Per unit*	*Per unit*
Fertilization	Acre	$ 1.00		$ 14.00	$ 15.00
Irrigation	Acre	5.00		4.00	9.00
Drainage	Acre				
Brush control—mechanical	Acre	2.50	$ .50	4.00	7.00
Brush control—chemical	Acre	.60	.40	2.80	3.80
Brush control—biological	Acre				
Brush control—fire	Acre	.50	4.00	1.00	5.50
Debris disposal	Acre	.25	.75	1.00	2.00
Undesirable forb control	Acre	6.00		9.00	15.00
Mechanical soil treatments	Acre	1.00	.50	4.50	6.00
Seeding	Acre	1.00	.50	5.00	6.50
Prescribed burning	Acre	.50	1.50	1.00	3.00
Rodent control	Acre	1.00		2.50	3.50
Insect and disease control	Acre	.50		1.00	1.50
Small water developments	Each site	100.00	50.00	200.00	350.00
Large water developments	Each site	400.00	550.00	1,050.00	2,000.00
Fences	Mile	50.00	450.00	500.00	1,000.00
Timber thinning	Acre				

[1] This resource unit is in the Sagebrush ecosystem, moderately high productivity class, and good condition.

[2] Costs expressed here are in acres, miles (i.e. "units"). Total costs for the resource unit are determined by multiplying costs/unit by acres in the resource unit.

TABLE 27.—*Expected life of practices by ecosystems*

(Years)

[Where no information is shown, the practice is not applicable or is not in general usage]

Ecogroup and ecosystem	Fertilization	Irrigation	Drainage	Brush control—mechanical	Brush control—chemical	Brush control—biological	Brush control—fire	Debris disposal	Undesirable forb control	Mechanical soil treatments	Seeding	Prescribed burning	Rodent control	Small water developments	Large water developments	Fences	Timber thinning	Insect and disease control
Western Range:																		
Sagebrush	1	30	-----	15	10	-----	8	15	15	25	30	5	30	25	30	30	-----	20
Desert shrub	3	30	-----	8	5	-----	8	8	20	25	30	5	30	30	30	30	-----	20
Southwestern shrubsteppe	3	30	-----	8	5	-----	8	8	20	25	30	5	30	30	30	30	-----	20
Chaparral-mountain shrub	2	30	-----	8	5	-----	5	8	20	20	30	5	30	30	30	30	-----	20
Pinyon-juniper	3	30	-----	20	20	-----	20	20	20	20	30	5	30	30	30	30	-----	20
Mountain grasslands	2	30	30	20	20	-----	15	20	15	20	30	5	30	30	30	25	-----	20
Mountain meadows	1	30	30	5	5	-----	5	5	15	20	30	5	15	30	30	25	-----	20
Desert grasslands	3	30	-----	8	5	-----	8	8	20	25	30	5	30	30	30	30	-----	20
Annual grasslands	3	30	-----	25	25	-----	25	25	15	20	30	5	30	30	30	30	-----	20
Alpine	1	-----	-----	5	5	-----	5	5	20	20	30	-----	30	30	30	15	-----	20
Western Forest:																		
Douglas-fir	1	30	-----	10	8	-----	8	30	15	25	30	5	30	25	30	25	30	20
Ponderosa pine	1	30	-----	10	8	-----	8	30	15	25	30	5	30	25	30	30	30	20
Western white pine	1	30	-----	8	5	-----	5	30	10	25	30	5	30	25	30	30	30	20
Fir-spruce	1	30	-----	10	8	-----	8	30	15	25	30	5	30	25	30	20	20	20
Hemlock-Sitka spruce	1	-----	30	5	3	-----	-----	30	20	25	30	-----	30	25	-----	25	30	20
Larch	1	30	-----	8	5	-----	5	30	10	25	30	5	30	25	30	30	30	20
Lodgepole pine	1	30	-----	10	8	-----	8	30	15	25	30	5	30	25	30	20	30	20
Redwood	1	30	-----	10	8	-----	8	30	15	25	30	5	30	25	30	25	30	20
Hardwoods	3	30	-----	10	8	-----	8	10	15	20	30	5	30	30	30	30	30	20
Great Plains:																		
Shinnery	3	30	-----	8	5	-----	5	8	20	20	30	5	30	30	30	30	-----	20
Texas savanna	3	30	30	8	5	-----	8	8	20	25	30	5	30	30	30	30	-----	20
Plains grasslands	2	30	-----	8	5	-----	8	8	10	20	30	5	30	30	30	30	-----	20
Prairie	2	30	30	20	20	-----	20	20	20	20	30	5	30	25	30	30	-----	20
Eastern Forest:																		
White-red-jack pine	1	30	30	5	3	-----	5	30	20	25	30	5	30	30	30	20	20	20
Spruce-fir	1	30	30	5	3	-----	5	30	20	25	30	5	30	30	30	20	20	20
Longleaf-slash pine	1	30	30	5	5	-----	5	30	20	20	30	5	30	20	30	20	20	20
Loblolly-shortleaf pine	1	30	-----	5	5	-----	5	30	20	20	30	5	30	20	30	20	20	20
Oak-pine	1	30	-----	5	5	-----	5	30	20	20	30	5	30	20	30	20	30	20
Oak-hickory	5	30	30	5	5	-----	5	30	20	20	30	5	30	20	30	20	30	20
Oak-gum-cypress	1	-----	30	3	4	-----	3	30	20	20	30	5	30	20	30	15	30	20
Elm-ash-cottonwood	1	30	-----	5	5	-----	5	30	15	25	30	5	30	30	30	20	30	20
Maple-beech-birch	1	30	-----	5	3	-----	5	30	20	25	30	5	30	30	30	20	20	20
Aspen-birch	1	30	30	5	3	-----	5	30	20	25	30	5	30	30	30	20	20	20
Wet grasslands	1	-----	30	15	5	-----	5	15	20	30	30	3	30	30	30	15	-----	20

TABLE 28.—*Annual maintenance and repair costs for management practices*

Ecogroup and Ecosystem	Irrigation	Drainage	Small water developments	Large water developments	Fences
	Per acre	*Per acre*	*Each*	*Each*	*Per mile*
Western Range:					
Sagebrush	$0.50		$25	$55	$40
Desert shrub	2.50		25	55	15
Southwestern shrubsteppe	1.00		25	55	20
Chaparral-mountain shrub	3.00		25	55	50
Pinyon-juniper	.50		25	55	40
Mountain grasslands	.25	$0.25	20	50	50
Mountain meadows	.25	.25	20	45	50
Desert grasslands	1.50		25	55	15
Annual grasslands	3.00		25	55	15
Alpine			20	45	80
Western Forest:					
Douglas-fir	.50		25	55	50
Ponderosa pine	.50		25	55	50
Western white pine	.50		25	55	50
Fir-spruce	.25		20	45	60
Hemlock-Sitka spruce		.50	25		40
Larch	.50		25	55	40
Lodgepone pine	.75		25	55	60
Redwood	1.00		25	55	50
Hardwoods	1.00		25	55	50
Great Plains:					
Shinnery	3.00		25	55	15
Texas savanna	.50	.25	25	55	20
Plains grasslands	.50		25	55	20
Prairie	.50	.25	25	55	20
Eastern Forest:					
White-red-jack pine	.50	.50	20	40	30
Spruce-fir	.50	.50	20	40	30
Longleaf-slash pine	.50	1.00	20	40	30
Loblolly-shortleaf pine	.50		20	40	30
Oak-pine	.50		15	30	30
Oak-hickory	.50	.25	15	30	30
Oak-gum-cypress		.50	15	30	40
Elm-ash-cottonwood	.75		25	40	40
Maple-beech-birch	.50		20	50	30
Aspen-birch	.50	.50	15	35	30
Wet grasslands		.75	10	20	30

APPENDIX C—BASIC STATISTICS, 1970 RESOURCE BASE

The 25 tables presented here give detailed acreage statistics for the forest-range lands and basic management and resource output statistics. In addition, most summaries for these tables are included in Chapter II, Resource Situation—1970. In some tables, totals shown will not add due to rounding.

TABLE 29.—*Land inventory of the 48 States, 1970*
(Thousand acres)

Region and State	Forest-range environment [1]	Improved private pasture [2]	Other lands [3]	Total land area [4]
Western				
Arizona	63,204	79	9,405	72,688
California	66,694	1,773	31,740	100,207
Colorado	51,003	1,354	14,129	66,486
Idaho	42,317	1,450	9,166	52,933
Montana	75,464	1,683	16,124	93,271
Nevada	63,969	532	5,763	70,264
New Mexico	71,448	69	6,249	77,766
Oregon	53,623	674	7,302	61,599
Utah	45,181	322	7,194	52,697
Washington	31,401	605	10,688	42,694
Wyoming	57,367	320	4,656	62,343
Total	621,671	8,861	122,416	752,948
Plains				
Kansas	15,701	1,451	35,359	52,511
Nebraska	24,958	1,459	22,615	49,032
North Dakota	12,543	1,441	30,468	44,452
Oklahoma	22,044	4,241	17,803	44,088
South Dakota	25,895	1,345	21,642	48,882
Texas	112,711	14,082	41,425	168,218
Total	213,852	24,019	169,312	407,183
Northeast				
Connecticut	1,992	131	1,012	3,135
Delaware	397	29	840	1,266
District of Columbia			39	39
Illinois	3,807	3,345	28,643	35,795
Indiana	3,902	2,298	16,958	23,158
Iowa	2,493	3,969	29,398	35,860
Kentucky	11,776	5,165	8,571	25,512
Maine	17,844	150	1,854	19,848
Maryland	2,978	457	2,884	6,319
Massachusetts	3,289	127	1,619	5,035
Michigan	19,478	1,268	15,746	36,492
Minnesota	19,513	2,970	28,723	51,206
Missouri	14,979	7,884	21,385	44,248
New Hampshire	5,155	61	553	5,769
New Jersey	2,247	116	2,450	4,813
New York	17,188	2,235	11,258	30,681
Ohio	6,433	2,735	17,054	26,222
Pennsylvania	17,062	1,772	9,970	28,804
Rhode Island	431	20	226	677
Vermont	4,370	429	1,138	5,937
West Virginia	11,480	1,837	2,094	15,411
Wisconsin	15,178	2,872	16,961	35,011
Total	181,992	39,870	219,376	441,238

See footnotes end of table.

TABLE 29.—*Land inventory of the 48 States, 1970—Continued*

(Thousand acres)

Region and State	Forest-range environment [1]	Improved private pasture [2]	Other lands [3]	Total land area [4]
Southeast				
Alabama	21,755	3,487	7,436	32,678
Arkansas	18,743	3,245	11,611	33,599
Florida	19,534	2,827	12,360	34,721
Georgia	27,491	2,814	6,990	37,295
Louisiana	15,824	2,402	10,642	28,868
Mississippi	16,995	3,971	9,257	30,223
North Carolina	20,716	1,654	9,033	31,403
South Carolina	12,582	1,038	5,754	19,374
Tennessee	13,831	3,464	9,433	26,728
Virginia	16,615	3,409	5,472	25,496
Total	184,086	28,311	87,988	300,385
48-State Total	1,201,601	101,061	599,092	1,901,754

[1] Compiled in Forest-Range Environmental Study, using information supplied by Forest Survey, Division of Forest Economics and Marketing Research and Division of Range Management, Forest Service, and National Inventory of Soil and Water Conservation Needs, 1967, U.S. Dept. of Agriculture; Bureau of Land Management, Bureau of Indian Affairs, Bureau of Sport Fisheries and Wildlife, and National Park Service, U.S. Dept. of Interior.

[2] National Inventory of Soil and Water Conservation Needs, 1967, Conservation Needs Inventory Committee of the U.S. Dept. of Agriculture, January 1971.

[3] Includes urban areas, rural highways, railroads, airports, cropland, farmsteads, farm roads and lanes, reported in "Major Uses of Land and Water in the United States, Summary for 1964," and miscellaneous Federal and other lands.

[4] Public Land Statistics, 1969, U.S. Dept. of the Interior.

TABLE 30.—*Land area of Western Range and Great Plains ecosystems in 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	Western Range ecosystems											Great Plains ecosystems				
	Sagebrush	Desert shrub	Southwestern shrub-steppe	Chaparral-mountain shrub	Pinyon-juniper	Mountain grasslands	Mountain meadows	Desert grasslands	Annual grasslands	Alpine[1]	Total	Shinnery	Texas savanna	Plains grasslands	Prairie[2]	Total
Arizona	988	17,934	13,568	4,907	8,457	6,191	9	6,327	-------	200	58,581	-------	-------	-------	-----	-------
Arkansas	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	330	330
California	2,949	8,559	-------	13,651	1,819	4,293	847	-------	6,700	1,512	40,330	-------	-------	-------	-------	-------
Colorado	3,959	744	-------	2,207	5,419	6,281	654	-------	-------	2,091	21,355	-------	-------	14,506	809	15,315
Florida	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	258	258
Idaho	13,673	272	-------	1,186	393	5,696	479	-------	-------	890	22,589	-------	-------	-------	-------	-------
Iowa	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	9	9
Kansas	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	12,114	2,227	14,341
Louisiana	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	155	155
Minnesota	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	40	40
Missouri	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	20	20
Montana	5,865	1,000	-------	846	1	13,027	530	-------	-------	648	21,917	-------	-------	31,153	-------	31,153
Nebraska	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	9,618	14,282	23,900
Nevada	27,238	21,319	-------	2,829	4,518	7,436	13	70	-------	2	63,425	-------	-------	-------	-------	-------
New Mexico	1,714	4,506	7,608	2,808	8,548	9,521	346	13,521	-------	77	48,649	322	-------	15,564	-------	15,886
North Dakota	-------	-------	-------	12	10	-------	-------	-------	-------	-------	22	-------	-------	11,390	586	11,976
Oklahoma	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	367	-------	10,908	1,218	12,493
Oregon	13,064	977	-------	386	1,767	7,989	247	-------	-------	711	25,141	-------	-------	-------	-------	-------
Pennsylvania	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	2	2
South Dakota	21	-------	-------	52	-------	136	3	-------	-------	-------	212	-------	-------	21,660	2,263	23,923
Texas	-------	16,268	17,425	220	44	-------	-------	2,412	-------	-------	36,369	1,315	15,221	28,529	16,148	61,213
Utah	6,228	9,730	-------	1,992	11,695	6,495	162	3,768	-------	506	40,576	-------	-------	-------	-------	-------
Washington	1,657	-------	-------	270	-------	6,167	204	-------	-------	617	8,915	-------	-------	-------	-------	-------
Wisconsin	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	27	27
Wyoming	16,863	4,734	-------	715	6	6,607	551	-------	-------	1,068	30,544	-------	-------	17,818	-------	17,818
Total	94,219	86,043	38,601	32,081	42,677	79,839	4,045	26,098	6,700	8,322	418,625	2,004	15,221	173,260	38,374	228,859

[1] Includes barren areas above treeline.

[2] Contains portions of Prairie that extend out of the Great Plains.

TABLE 31.—*Land area of National Forest System, Western Range, and Great Plains ecosystems in 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	Western Range ecosystems											Great Plains ecosystems				
	Sagebrush	Desert shrub	Southwestern shrub-steppe	Chaparral-mountain shrub	Pinyon-juniper	Mountain grasslands	Mountain meadows	Desert grasslands	Annual grasslands	Alpine[1]	Total	Shinnery	Texas savanna	Plains grasslands	Prairie[2]	Total
Arizona	13	837	864	1,105	3,689	1,013	9	1,013	-------	200	8,743	-------	-------	-------	-------	-------
California	1,444	1,679	-------	2,266	997	296	639	-------	-------	1,512	8,833	-------	-------	-------	-------	-------
Colorado	201	-------	-------	664	137	870	250	-------	-------	2,058	4,180	-------	-------	483	15	498
Idaho	2,481	-------	-------	974	99	731	253	-------	-------	890	5,428	-------	-------	-------	-------	-------
Kansas	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	29	79	108
Missouri	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	10	10
Montana	491	-------	-------	129	-------	1,003	117	-------	-------	647	2,387	-------	-------	441	-------	441
Nebraska	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	201	86	287
Nevada	2,278	1,446	-------	174	618	142	13	-------	-------	2	4,673	-------	-------	-------	-------	-------
New Mexico	93	-------	204	31	3,802	367	48	183	-------	77	4,805	-------	-------	367	-------	367
North Dakota	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	1,028	53	1,081
Oklahoma	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	17	-------	28	5	50
Oregon	243	-------	-------	47	132	847	119	-------	-------	711	2,099	-------	-------	-------	-------	-------
South Dakota	21	-------	-------	40	-------	136	3	-------	-------	-------	200	-------	-------	770	-------	770
Texas	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	64	5	5	5	79
Utah	1,078	1,026	-------	1,001	754	411	76	-------	-------	506	4,852	-------	-------	-------	-------	-------
Washington	210	-------	-------	182	-------	478	148	-------	-------	617	1,635	-------	-------	-------	-------	-------
Wyoming	1,449	1	-------	127	2	860	246	-------	-------	1,068	3,753	-------	-------	212	-------	212
Total	10,002	4,989	1,068	6,740	10,230	7,154	1,921	1,196	-------	8,288	51,588	81	5	3,564	253	3,903

[1] Includes barren areas above treeline.

[2] Contains portions of Prairie that extend out of the Great Plains.

TABLE 32.—*Other Federal land area, Western Range and Great Plains ecosystems, 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	Western Range ecosystems											Great Plains ecosystems				
	Sagebrush	Desert shrub	Southwestern shrub-steppe	Chaparral-mountain shrub	Pinyon-juniper	Mountain grasslands	Mountain meadows	Desert grasslands	Annual grasslands	Alpine[1]	Total	Shinnery	Texas savanna	Plains grasslands	Prairie[2]	Total
Arizona	975	11,901	2,429	1,482	595	41	-------	177	-------	-------	17,600	-------	-------	-------	-------	-------
California	1,167	6,771	-------	4,988	324	35	-------	-------	445	-------	13,730	-------	-------	-------	-------	-------
Colorado	2,384	744	-------	1,465	2,959	647	7	-------	-------	33	8,239	-------	-------	130	-------	130
Idaho	8,877	272	-------	212	294	846	9	-------	-------	-------	10,510	-------	-------	-------	-------	-------
Iowa	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	1	1
Kansas	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	6	16	22
Minnesota	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	1	1
Montana	3,208	1,000	-------	205	1	424	26	-------	-------	1	4,865	-------	-------	4,033	-------	4,033
Nebraska	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	10	85	95
Nevada	24,266	19,870	-------	2,655	3,720	1,276	-------	70	-------	-------	51,857	-------	-------	-------	-------	-------
New Mexico	1,222	319	7,404	38	2	482	-------	7,359	-------	-------	16,826	5	-------	246	-------	251
North Dakota	-------	-------	-------	12	10	-------	-------	-------	-------	-------	22	-------	-------	252	-------	252
Oklahoma	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	58	11	69
Oregon	9,448	977	-------	339	1,635	873	-------	-------	-------	-------	13,272	-------	-------	-------	-------	-------
Pennsylvania	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	2	2
South Dakota	-------	-------	-------	12	-------	-------	-------	-------	-------	-------	12	-------	-------	517	-------	517
Texas	-------	-------	457	220	44	-------	-------	47	-------	-------	768	-------	145	144	60	349
Utah	4,218	8,704	-------	991	7,801	547	12	1,996	-------	-------	24,269	-------	-------	-------	-------	-------
Washington	530	-------	-------	88	-------	219	-------	-------	-------	-------	837	-------	-------	-------	-------	-------
Wisconsin	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	27	27
Wyoming	10,857	4,733	-------	76	4	257	85	-------	-------	-------	16,012	-------	-------	1,356	-------	1,356
Total	67,152	55,291	10,290	12,783	17,389	5,647	139	9,649	445	34	178,819	5	145	6,752	203	7,105

[1] Includes barren areas above treeline.

[2] Contains portions of Prairie that extend out of the Great Plains.

TABLE 33.—*Non-Federal land area, Western Range and Great Plains ecosystems, 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	Western Range ecosystems											Great Plains ecosystems				
	Sagebrush	Desert shrub	Southwestern shrub-steppe	Chaparral-mountain shrub	Pinyon-juniper	Mountain grasslands	Mountain meadows	Desert grasslands	Annual grasslands	Alpine[1]	Total	Shinnery	Texas savanna	Plains grasslands	Prairie[2]	Total
Arizona	-------	5,196	10,275	2,320	4,173	5,137	-------	5,137	-------	-------	32,238	-------	-------	-------	-------	-------
Arkansas	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	330	330
California	338	109	-------	6,397	498	3,962	208	-------	6,255	-------	17,767	-------	-------	-------	-------	-------
Colorado	1,374	-------	-------	78	2,323	4,764	397	-------	-------	-------	8,936	-------	-------	13,893	794	14,687
Florida	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	258	258
Idaho	2,315	-------	-------	-------	-------	4,119	217	-------	-------	-------	6,651	-------	-------	-------	-------	-------
Iowa	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	8	8
Kansas	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	12,079	2,132	14,211
Louisiana	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	155	155
Minnesota	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	39	39
Missouri	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	10	10
Montana	2,166	-------	-------	512	-------	11,600	387	-------	-------	-------	14,665	-------	-------	26,679	-------	26,679
Nebraska	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	9,407	14,111	23,518
Nevada	694	3	-------	-------	180	6,018	-------	-------	-------	-------	6,895	-------	-------	-------	-------	-------
New Mexico	399	4,187	-------	2,739	4,744	8,672	298	5,979	-------	-------	27,018	317	-------	14,951	-------	15,268
North Dakota	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	10,110	533	10,643
Oklahoma	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	350	-------	10,822	1,202	12,374
Oregon	3,373	-------	-------	-------	-------	6,269	128	-------	-------	-------	9,770	-------	-------	-------	-------	-------
South Dakota	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	20,373	2,263	22,636
Texas	-------	16,268	16,968	-------	-------	-------	-------	2,365	-------	-------	35,601	1,251	15,071	28,380	16,083	60,785
Utah	932	-------	-------	-------	3,140	5,537	74	1,772	-------	-------	11,455	-------	-------	-------	-------	-------
Washington	917	-------	-------	-------	-------	5,470	56	-------	-------	-------	6,443	-------	-------	-------	-------	-------
Wyoming	4,557	-------	-------	512	-------	5,490	220	-------	-------	-------	10,779	-------	-------	16,250	-------	16,250
Total	17,065	25,763	27,243	12,558	15,058	67,038	1,985	15,253	6,255	-------	188,218	1,918	15,071	162,944	37,918	217,851

[1] Includes barren areas above treeline.

[2] Contains portions of Prairie that extend out of the Great Plains.

TABLE 34.—*Land area of Western Forest ecosystems in 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Hardwoods	Total
Arizona	137	4,251	-------	111	-------	-------	-------	-------	79	4,578
California	3,552	7,748	26	3,489	35	-------	426	923	10,009	26,208
Colorado	1,501	2,419	262	4,524	-------	-------	2,363	-------	3,237	14,306
Idaho	7,132	2,075	1,349	3,050	780	2,117	2,523	-------	667	19,693
Montana	5,569	3,870	1,447	2,345	69	2,158	6,293	-------	504	22,255
Nebraska	-------	316	-------	-------	-------	-------	-------	-------	-------	316
Nevada	21	103	168	143	61	-------	13	-------	29	538
New Mexico	1,122	4,680	43	651	-------	-------	-------	-------	398	6,894
Oregon	10,246	6,412	71	3,686	1,659	112	2,315	5	3,946	28,452
South Dakota	-------	1,421	-------	23	-------	-------	-------	-------	10	1,454
Utah	752	465	38	1,250	-------	-------	604	-------	1,429	4,538
Washington	7,886	2,816	78	3,050	4,472	757	852	-------	2,506	22,417
Wyoming	1,017	992	571	2,062	-------	-------	3,754	-------	584	8,980
Total	38,935	37,568	4,053	24,384	7,076	5,144	19,143	928	23,398	160,629

TABLE 35.—*Land area of National Forest System, Western Forest ecosystems in 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Hardwoods	Total
Arizona	132	2,509	-------	17	-------	-------	-------	-------	36	2,694
California	1,794	4,657	23	2,074	6	-------	249	2	2,402	11,207
Colorado	902	1,005	117	3,818	-------	-------	1,734	-------	2,080	9,656
Idaho	5,583	1,203	1,202	2,858	302	1,217	2,222	-------	337	14,924
Montana	3,290	1,141	1,370	1,812	54	1,420	4,693	-------	62	13,842
Nebraska	-------	63	-------	-------	-------	-------	-------	-------	-------	63
Nevada	21	26	163	98	60	-------	5	-------	28	401
New Mexico	624	2,828	4	375	-------	-------	-------	-------	184	4,015
Oregon	4,044	3,529	63	2,872	567	112	1,678	5	491	13,361
South Dakota	-------	993	-------	20	-------	-------	-------	-------	-------	1,013
Utah	402	363	13	1,030	-------	-------	520	-------	843	3,171
Washington	2,698	676	69	1,769	1,215	510	412	-------	60	7,409
Wyoming	721	221	443	1,649	-------	-------	2,014	-------	262	5,310
Total	20,211	19,214	3,467	18,392	2,204	3,259	13,527	7	6,785	87,066

TABLE 36.—*Other Federal land area, Western Forest ecosystems, 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Hardwoods	Total
Arizona		290								290
California	89	290	3	276			85	58	1,067	1,868
Colorado	123	116	8	182			137		174	740
Idaho	252	40	20	5	27	40	84		52	520
Montana	346	316	17	291		138	542		23	1,673
Nebraska		2								2
Nevada				1						1
New Mexico	20	53	2	12					5	92
Oregon	1,739	261		100	100		125		212	2,537
South Dakota		27								27
Utah	93	27	6	68			19		27	240
Washington	494	46		600	384	20	24		32	1,600
Wyoming	120	182	79	251			1,565		68	2,265
Total	3,276	1,650	135	1,786	511	198	2,581	58	1,660	11,855

TABLE 37.—*Non-Federal land area, Western Forest ecosystems, 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Hardwoods	Total
Arizona	5	1,452		94					43	1,594
California	1,669	2,801		1,139	29		92	863	6,540	13,133
Colorado	476	1,298	137	524			492		983	3,910
Idaho	1,297	832	127	187	451	860	217		278	4,249
Montana	1,933	2,413	60	242	15	600	1,058		419	6,740
Nebraska		251								251
Nevada		77	5	44	1		8		1	136
New Mexico	478	1,799	37	264					209	2,787
Oregon	4,463	2,622	8	714	992		512		3,243	12,554
South Dakota		401		3					10	414
Utah	257	85	19	152			65		559	1,127
Washington	4,694	2,094	9	681	2,873	227	416		2,414	13,408
Wyoming	176	589	49	162			175		254	1,405
Total	15,448	16,704	451	4,206	4,361	1,687	3,035	863	14,953	61,708

TABLE 38.—*Land area of Eastern Forest ecosystems, 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cotton-wood	Maple-beech-birch	Aspen-birch	Wet grass-lands	Total
Alabama			1,986	7,481	4,865	5,042	2,280	94			7	21,755
Arizona											45	45
Arkansas				3,734	3,064	8,460	2,771	274			110	18,413
California											156	156
Colorado											27	27
Connecticut	96					1,391		298	109	98		1,992
Delaware				198	22	83	89				5	397
Florida			7,905	1,386	1,064	1,270	5,528	85			2,038	19,276
Georgia	19		6,314	8,481	3,782	3,657	5,154				84	27,491
Idaho											35	35
Illinois				45	12	2,256	16	1,442	14	9	13	3,807
Indiana	3			57	41	2,421	55	535	781	9		3,902
Iowa						1,251		1,113	72	18	28	2,484
Kansas					2	764		580			14	1,360
Kentucky			36	701	557	9,272	130	751	304		25	11,776
Louisiana			1,200	4,315	2,202	1,402	5,540	658			352	15,669
Maine	1,672	8,876				288		523	5,224	1,256	5	17,844
Maryland	39	12		609	299	1,453	371	130	43	10	12	2,978
Massachusetts	577	28		165	221	1,262		277	468	285	6	3,289
Michigan	2,011	3,399				2,121		1,789	5,341	4,793	24	19,478
Minnesota	1,542	5,889				1,330		2,098	1,033	7,526	55	19,473
Mississippi			1,320	4,255	3,410	4,330	3,286	342			52	16,995
Missouri				361	661	11,463	402	1,985	77		10	14,959
Montana											139	139
Nebraska						189		540			13	742
Nevada											6	6
New Hampshire	1,423	1,190				617		121	1,346	458		5,155
New Jersey	17			821	130	806		397	38	21	17	2,247
New Mexico											14	14
New York	1,827	1,561			302	1,356		3,397	7,428	1,309	8	17,188
North Carolina	134	18	513	6,715	3,604	6,363	2,695	319	307		48	20,716
North Dakota						95		212		140	98	545
Ohio	55	19	11	196	487	3,003	29	1,388	1,177	65	3	6,433
Oklahoma			6	807	685	7,583	339	113			18	9,551
Oregon											30	30
Pennsylvania	952			208	142	7,981	200	2,072	3,565	1,938	2	17,060
Rhode Island	8			10	27	283		76		27		431
South Carolina	9		1,121	4,575	2,196	2,535	1,802	284			60	12,582
South Dakota						68		223			15	306
Tennessee	141	16	85	1,348	1,360	9,711	681	219	237		33	13,831
Texas			348	5,089	2,422	4,276	2,295	81			618	15,129
Utah											67	67
Vermont	601	764			63	111		557	2,019	252	3	4,370
Virginia	65			2,998	2,729	10,327	263	135	78		20	16,615
Washington											69	69
West Virginia	88	92	44	540	115	7,503	148	611	2,339			11,480
Wisconsin	1,277	1,731				2,756		1,319	3,633	4,350	85	15,151
Wyoming											25	25
Total	12,556	23,595	20,889	55,095	34,464	125,081	34,074	25,038	35,633	22,564	4,494	393,483

TABLE 39.—*Land area of National Forest System, Eastern Forest ecosystems, 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cotton-wood	Maple-beech-birch	Aspen-birch	Wet grass-lands	Total
Alabama			95	218	141	172	6					632
Arkansas				723	523	1,187	16					2,449
Florida			507	284	97		167				25	1,080
Georgia	15		1	163	188	436	10					813
Illinois				42		167		28				237
Indiana				26		123						149
Kentucky			36		69	417	2	16	8			548
Louisiana			185	251	81	35	41					593
Maine	7	19						1	19	4		50
Michigan	683	474				195		67	634	613		2,666
Minnesota	536	809				8		36	126	1,265		2,780
Mississippi			195	379	272	155	134					1,135
Missouri				221	188	988		9				1,406
New Hampshire	12	381							253	34		680
New York									14			14
North Carolina	23	5	10	158	132	707	22		71			1,128
North Dakota						5		11		8		24
Ohio	2		11		7	84	3	11	11	3		132
Oklahoma				104	61	73						238
Pennsylvania					29	58			388	19		494
South Carolina			41	335	97	56	42	20				591
Tennessee	17			99	99	370			23			608
Texas			11	565	70	19	27	5				697
Vermont	3	24				6		6	188	12		239
Virginia	8			55	167	1,263		18	1			1,512
West Virginia	16	92	43			278			508			937
Wisconsin	176	371				30		62	451	396		1,486
Total	1,498	2,175	1,135	3,623	2,221	6,832	470	290	2,695	2,354	25	23,318

TABLE 40.—*Other Federal land area, Eastern Forest ecosystems, 1970* ..

(Thousand acres)

[Totals may not add due to rounding]

State	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cotton-wood	Maple-beech-birch	Aspen-birch	Wet grass-lands	Total
Alabama	------	------	16	60	42	53	21	------	------	------	7	199
Arizona	------	------	------	------	------	------	------	------	------	------	45	45
Arkansas	------	------	------	9	29	110	142	16	------	------	110	416
California	------	------	------	------	------	------	------	------	------	------	156	156
Colorado	------	------	------	------	------	------	------	------	------	------	27	27
Connecticut	------	------	------	------	------	1	------	------	------	------	------	1
Delaware	------	------	------	1	------	------	------	------	------	------	5	6
Florida	------	------	307	65	130	39	395	------	------	------	982	1,918
Georgia	------	------	231	165	93	47	372	------	------	------	84	992
Idaho	------	------	------	------	------	------	------	------	------	------	35	35
Illinois	------	------	------	------	5	17	------	23	------	------	13	58
Indiana	------	------	------	2	2	63	2	5	7	------	------	81
Iowa	------	------	------	------	------	5	------	4	------	------	28	37
Kansas	------	------	------	------	------	13	------	13	------	------	14	40
Kentucky	------	------	------	17	32	185	1	7	4	------	25	271
Louisiana	------	------	32	22	20	7	76	10	------	------	119	286
Maine	6	33	------	------	------	------	------	4	17	4	5	69
Maryland	------	------	------	10	1	26	21	1	------	------	12	71
Massachusetts	5	------	------	1	2	19	------	2	2	3	6	40
Michigan	------	14	------	------	------	------	------	------	12	27	24	77
Minnesota	11	72	------	------	------	7	------	18	6	64	55	233
Mississippi	------	------	22	43	52	29	41	6	------	------	52	245
Missouri	------	------	------	------	23	19	6	4	------	------	10	62
Montana	------	------	------	------	------	------	------	------	------	------	139	139
Nebraska	------	------	------	------	------	4	------	11	------	------	13	28
Nevada	------	------	------	------	------	------	------	------	------	------	6	6
New Hampshire	------	10	------	------	------	------	------	------	5	1	------	16
New Jersey	------	------	------	7	2	7	------	39	------	------	17	72
New Mexico	------	------	------	------	------	------	------	------	------	------	14	14
New York	16	17	------	------	2	6	------	14	39	6	8	108
North Carolina	3	1	47	109	43	341	24	1	5	------	48	622
North Dakota	------	------	------	------	------	11	------	27	------	17	98	153
Ohio	2	------	------	------	2	16	------	3	12	------	3	38
Oklahoma	------	------	2	10	13	201	12	4	------	------	18	260
Oregon	------	------	------	------	------	------	------	------	------	------	30	30
Pennsylvania	1	------	------	------	------	28	------	6	5	2	2	44
South Carolina	------	------	96	88	39	39	31	3	------	------	60	356
South Dakota	------	------	------	------	------	6	------	------	------	------	15	21
Tennessee	52	16	34	13	66	253	17	7	37	------	33	528
Texas	------	------	------	52	19	67	22	------	------	------	145	305
Utah	------	------	------	------	------	------	------	------	------	------	67	67
Vermont	------	2	------	------	------	------	------	1	6	------	3	12
Virginia	2	------	------	68	73	340	7	------	------	------	20	510
Washington	------	------	------	------	------	------	------	------	------	------	69	69
West Virginia	------	------	1	------	------	31	------	2	------	------	------	34
Wisconsin	14	15	------	------	------	11	------	10	23	50	85	208
Wyoming	------	------	------	------	------	------	------	------	------	------	25	25
Total	112	180	788	742	690	2,001	1,190	241	180	174	2,732	9,030

TABLE 41.—*Non-Federal land area, Eastern Forest ecosystems, 1970*

(Thousand acres)

[Totals may not add due to rounding]

State	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cotton-wood	Maple-beech-birch	Aspen-birch	Wet grass-lands	Total
Alabama	-------	-------	1,875	7,203	4,682	4,817	2,253	94	-------	-------	-------	20,924
Arkansas	-------	-------	-------	3,002	2,512	7,163	2,613	258	-------	-------	-------	15,548
Connecticut	96	-------	-------	-------	-------	1,390	-------	298	109	98	-------	1,991
Delaware	-------	-------	-------	197	22	83	89	-------	-------	-------	-------	391
Florida	-------	-------	7,091	1,037	837	1,231	4,966	85	-------	-------	1,031	16,278
Georgia	4	-------	6,082	8,153	3,501	3,174	4,772	-------	-------	-------	-------	25,686
Illinois	-------	-------	-------	3	7	2,072	16	1,391	14	9	-------	3,512
Indiana	3	-------	-------	29	39	2,235	53	530	774	9	-------	3,672
Iowa	-------	-------	-------	-------	-------	1,248	-------	1,109	72	18	-------	2,447
Kansas	-------	-------	-------	-------	2	751	-------	567	-------	-------	-------	1,320
Kentucky	-------	-------	-------	684	456	8,670	127	728	292	-------	-------	10,957
Louisiana	-------	-------	983	4,042	2,101	1,360	5,423	648	-------	-------	233	14,790
Maine	1,659	8,824	-------	-------	-------	288	-------	518	5,188	1,248	-------	17,725
Maryland	39	12	-------	599	298	1,427	350	129	43	10	-------	2,907
Massachusetts	572	28	-------	164	219	1,243	-------	275	466	282	-------	3,249
Michigan	1,328	2,911	-------	-------	-------	1,926	-------	1,722	4,695	4,153	-------	16,735
Minnesota	995	5,008	-------	-------	-------	1,315	-------	2,044	901	6,197	-------	16,460
Mississippi	-------	-------	1,103	3,833	3,086	4,146	2,111	336	-------	-------	-------	15,615
Missouri	-------	-------	-------	140	450	10,456	396	1,972	77	-------	-------	13,491
Nebraska	-------	-------	-------	-------	-------	185	-------	529	-------	-------	-------	714
New Hampshire	1,411	799	-------	-------	-------	617	-------	121	1,088	423	-------	4,459
New Jersey	17	-------	-------	814	128	799	-------	258	38	21	-------	2,175
New York	1,811	1,544	-------	-------	300	1,350	-------	3,383	7,375	1,303	-------	17,066
North Carolina	108	12	456	6,448	3,429	5,315	2,649	318	231	-------	-------	18,966
North Dakota	-------	-------	-------	-------	-------	79	-------	174	-------	115	-------	368
Ohio	51	19	-------	196	478	2,903	26	1,374	1,154	62	-------	6,263
Oklahoma	-------	-------	4	693	611	7,309	327	109	-------	-------	-------	9,053
Pennsylvania	951	-------	-------	208	113	7,895	200	2,066	3,172	1,917	-------	16,522
Rhode Island	8	-------	-------	10	27	283	-------	76	-------	27	-------	431
South Carolina	9	-------	984	4,152	2,060	2,440	1,729	261	-------	-------	-------	11,635
South Dakota	-------	-------	-------	-------	-------	62	-------	223	-------	-------	-------	285
Tennessee	72	-------	51	1,236	1,195	9,088	664	212	177	-------	-------	12,695
Texas	-------	-------	337	4,472	2,333	4,190	2,246	76	-------	-------	473	14,127
Vermont	598	738	-------	-------	63	105	-------	550	1,825	240	-------	4,119
Virginia	55	-------	-------	2,875	2,489	8,724	256	117	77	-------	-------	14,593
West Virginia	72	-------	-------	540	115	7,194	148	609	1,831	-------	-------	10,509
Wisconsin	1,087	1,345	-------	-------	-------	2,715	-------	1,247	3,159	3,904	-------	13,457
Total	10,946	21,240	18,966	50,730	31,553	116,248	32,414	24,507	32,758	20,036	1,737	361,135

TABLE 42.— *Areas grazed and ungrazed by ecogroup, ecosystem, and ownership, 1970*

(Million acres)

[Totals may not add due to rounding]

Ecogroup by ecosystem	National Forest System			Other Federal land			Non-Federal land			All ownerships		Forest-Range environment
	Grazed	Ungrazed	Total	Grazed	Ungrazed	Total	Grazed	Ungrazed	Total	Grazed	Ungrazed	
Western Range:												
Sagebrush	9.9	.1	10.0	63.6	3.5	67.2	16.9	0.2	17.1	90.5	3.8	94.2
Desert shrub	1.1	3.9	5.0	43.5	11.7	55.3	14.1	11.6	25.8	58.8	27.3	86.0
Southwestern shrubsteppe	.9	.1	1.1	8.3	1.9	10.3	26.1	1.1	27.2	35.4	3.2	38.6
Chaparral-mountain shrub	6.6	.1	6.7	11.1	1.7	12.8	12.4	.2	12.6	30.1	2.0	32.1
Pinyon-juniper	8.4	1.8	10.2	12.6	4.8	17.4	13.2	1.9	15.1	34.2	8.5	42.7
Mountain grasslands	6.4	.7	7.2	5.1	.6	5.6	63.7	3.4	67.0	75.2	4.6	79.8
Mountain meadows	1.8	.1	1.9	.1	.1	.1	1.9	.1	2.0	3.8	.3	4.0
Desert grasslands	1.2	———	1.2	9.6	———	9.6	15.3	———	15.3	26.1	———	26.1
Annual grasslands	———	———	———	.4	(1)	.4	6.3	———	6.3	6.7	———	6.7
Alpine[2]	.2	8.1	8.3	(1)	(1)	(1)	———	———	———	.2	8.2	8.3
Total	36.6	15.0	51.6	154.5	24.3	178.8	169.8	18.4	188.2	360.8	57.8	418.5
Western Forest:												
Douglas-fir	9.6	10.6	20.2	.7	2.6	3.3	3.7	11.8	15.4	14.0	24.9	38.9
Ponderosa pine	19.1	.2	19.2	1.5	.2	1.6	14.9	1.8	16.7	35.5	2.1	37.6
Western white pine	1.4	2.1	3.5	———	.1	.1	———	.5	.5	1.4	2.7	4.1
Fir-spruce	7.4	11.0	18.4	———	1.8	1.8	———	4.2	4.2	7.4	17.0	24.4
Hemlock-Sitka spruce	———	2.2	2.2	———	.5	.5	———	4.4	4.4	———	7.1	7.1
Larch	3.3	———	3.3	.1	.1	.2	1.3	.3	1.7	4.7	.4	5.1
Lodgepole pine	9.5	4.0	13.5	.3	2.3	2.6	1.4	1.6	3.0	11.2	7.9	19.1
Redwood	———	(1)	(1)	———	.1	.1	———	.9	.9	———	.9	.9
Hardwoods	6.7	.1	6.8	1.5	.2	1.7	14.8	.1	15.0	23.0	.4	23.4
Total	56.9	30.1	87.1	4.1	7.7	11.9	36.2	25.5	61.7	97.2	63.4	160.6
Great Plains:												
Shinnery	.1	———	.1	(1)	(1)	(1)	1.9	(1)	1.9	2.0	(1)	2.0
Texas savanna	———	(1)	(1)	———	.1	.1	14.9	.2	15.1	14.9	.4	15.2
Plains grasslands	3.1	.5	3.6	5.7	1.1	6.8	155.0	8.0	162.9	163.7	10.0	173.3
Prairie	.3	(1)	.3	.1	.1	.2	36.2	1.7	37.9	36.5	1.8	38.4
Total	3.4	.5	3.9	5.8	1.4	7.1	208.0	9.9	217.9	217.1	11.8	228.9
Eastern Forest:												
White-red-jack pine	———	1.5	1.5	———	.1	.1	.2	10.8	10.9	.2	12.4	12.6
Spruce-fir	———	2.2	2.2	(1)	.2	.2	.2	21.0	21.2	.2	23.4	23.6
Longleaf-slash pine	.6	.5	1.1	(1)	.8	.8	14.0	5.0	19.0	14.6	6.3	20.9
Loblolly-shortleaf pine	1.9	1.7	3.6	.1	.7	.7	28.3	22.4	50.7	30.3	24.8	55.1
Oak-pine	.6	1.6	2.2	(1)	.7	.7	23.1	8.4	31.6	23.7	10.7	34.5
Oak-hickory	.3	6.5	6.8	.1	1.9	2.0	51.1	65.2	116.2	51.5	73.5	125.1
Oak-gum-cypress	(1)	.5	.5	(1)	1.2	1.2	9.8	22.6	32.4	9.8	24.2	24.1
Elm-ash-cottonwood	(1)	.3	.3	(1)	.2	.2	15.0	9.5	24.5	15.0	10.0	25.0
Maple-beech-birch	.1	2.6	2.7	(1)	.2	.2	7.7	25.0	32.8	7.8	27.9	35.6
Aspen-birch	.1	2.3	2.4	(1)	.1	.2	5.6	14.4	20.0	5.8	16.8	22.6
Wet grasslands	———	(1)	(1)	(1)	2.7	2.7	.9	.8	1.7	.9	3.6	4.5
Total	3.6	19.7	23.3	.2	8.7	9.0	155.9	205.2	361.1	159.8	233.6	393.6
Total 48 States	100.5	65.4	165.9	164.7	42.1	206.8	569.8	259.1	828.9	835.0	366.6	1,201.6

[1] Less than 50,000 acres.

[2] Includes barren areas above treeline.

TABLE 43.—*Forest-range grazed and ungrazed by State and ownership, 1970*

(Thousand acres)

[Totals may not add due to rounding]

States by Geographic Regions	National Forest System			Other Federal land			Non-Federal land			All ownerships		
	Grazed	Ungrazed	Total	Grazed	Ungrazed	Total	Grazed	Ungrazed	Total	Grazed	Ungrazed	Total
Western:												
Arizona	9,838	1,599	11,437	12,212	5,723	17,935	30,007	3,825	33,832	52,057	11,147	63,204
California	14,193	5,847	20,040	12,875	2,879	15,754	26,385	4,515	30,900	53,453	13,241	66,694
Colorado	8,904	5,430	14,334	7,391	1,745	9,136	25,132	2,401	27,533	41,427	9,576	51,003
Idaho	13,186	7,166	20,352	10,023	1,042	11,065	8,669	2,231	10,900	31,878	10,439	42,317
Montana	11,214	5,456	16,670	8,591	2,119	10,710	43,926	4,158	48,084	63,731	11,733	75,464
Nevada	3,464	1,610	5,074	46,541	5,323	51,864	6,651	380	7,031	56,656	7,313	63,969
New Mexico	8,113	1,073	9,186	15,440	1,743	17,183	41,185	3,894	45,079	64,738	6,710	71,448
Oregon	8,957	6,503	15,460	12,501	3,338	15,839	15,641	6,683	22,324	37,099	16,524	53,623
Utah	5,412	2,611	8,023	20,282	4,294	24,576	11,729	853	12,582	37,423	7,758	45,181
Washington	4,469	4,575	9,044	962	1,544	2,506	11,557	8,294	19,851	16,988	14,413	31,401
Wyoming	5,865	3,410	9,275	15,846	3,812	19,658	26,841	1,593	28,434	48,552	8,815	57,367
Total	93,615	45,280	138,895	162,664	33,562	196,226	247,723	38,827	286,550	504,002	117,669	621,671
Plains:												
Kansas	95	13	108	21	41	62	14,435	1,096	15,531	14,551	1,150	15,701
Nebraska	302	48	350	50	75	125	23,315	1,168	24,483	23,667	1,291	24,958
North Dakota	920	185	1,105	283	144	427	10,438	573	11,011	11,641	902	12,543
Oklahoma	195	93	288	122	207	329	15,227	6,200	21,427	15,544	6,500	22,044
South Dakota	1,832	151	1,983	486	91	577	22,167	1,168	23,335	24,485	1,410	25,895
Texas	669	107	776	878	544	1,422	93,681	16,842	110,523	95,218	17,493	112,711
Total	4,013	597	4,610	1,840	1,102	2,942	179,263	27,047	206,310	185,106	28,746	213,852
Northeast:												
Connecticut	----	----	----	----	1	1	1,147	844	1,991	1,147	845	1,992
Delaware	----	----	----	----	6	6	100	291	391	100	297	397
Illinois	----	237	237	----	58	58	2,288	1,224	3,512	2,288	1,519	3,807
Indiana	----	149	149	----	81	81	2,288	1,384	3,672	2,288	1,614	3,902
Iowa	----	----	----	----	38	38	1,628	827	2,455	1,628	865	2,493
Kentucky	----	548	548	5	266	271	3,189	7,768	10,957	3,194	8,582	11,776
Maine	----	50	50	----	69	69	1,517	16,208	17,725	1,517	16,327	17,844
Maryland	----	----	----	----	71	71	1,433	1,474	2,907	1,433	1,545	2,978
Massachusetts	----	----	----	----	40	40	1,284	1,965	3,249	1,284	2,005	3,289
Michigan	50	2,616	2,666	7	70	77	5,161	11,574	16,735	5,218	14,260	19,478
Minnesota	56	2,724	2,780	13	221	234	4,562	11,937	16,499	4,631	14,882	19,513
Missouri	33	1,383	1,416	5	57	62	6,574	6,927	13,501	6,612	8,367	14,979
New Hampshire	----	680	680	----	16	16	754	3,705	4,459	754	4,401	5,155
New Jersey	----	----	----	----	72	72	921	1,254	2,175	921	1,326	2,247
New York	----	14	14	----	108	108	4,656	12,410	17,066	4,656	12,532	17,188
Ohio	1	131	132	----	38	38	3,449	2,814	6,263	3,450	2,983	6,433
Pennsylvania	----	494	494	1	45	46	7,724	8,798	16,522	7,725	9,337	17,062
Rhode Island	----	----	----	----	----	----	258	173	431	258	173	431
Vermont	9	230	239	----	12	12	607	3,512	4,119	616	3,754	4,370
West Virginia	3	934	937	----	34	34	6,249	4,260	10,509	6,252	5,228	11,480
Wisconsin	33	1,453	1,486	23	212	235	5,490	7,967	13,457	5,551	9,627	15,178
Total	185	11,643	11,828	54	1,515	1,569	61,279	107,316	168,595	61,523	120,469	181,992

Southeast:												
Alabama	261	370	631	7	192	199	12,083	8,842	20,925	12,351	9,404	21,755
Arkansas	1,202	1,247	2,449	31	385	416	7,652	8,226	15,878	8,885	9,858	18,743
Florida	224	856	1,080	20	1,898	1,918	8,514	8,022	16,536	8,758	10,776	19,534
Georgia	17	796	813	7	985	992	14,352	11,334	25,680	14,376	13,115	27,491
Louisiana	372	221	593	9	277	286	8,745	6,200	14,945	9,126	6,698	15,824
Mississippi	503	632	1,135	12	233	245	7,446	8,169	15,615	7,961	9,034	16,995
North Carolina	12	1,116	1,128	16	606	622	8,097	10,869	18,966	8,125	12,591	20,716
South Carolina	27	564	591	3	353	356	4,974	6,661	11,635	5,004	7,578	12,582
Tennessee	8	600	608	9	519	528	4,199	8,496	12,695	4,216	9,615	13,831
Virginia	18	1,494	1,512	10	500	510	5,533	9,060	14,593	5,561	11,054	16,615
Total	2,644	7,896	10,540	124	5,948	6,072	81,595	85,879	167,474	84,363	99,723	184,086
48-State Total	100,457	65,416	165,873	164,682	42,127	206,809	569,860	259,069	828,929	834,994	366,612	1,201,601

TABLE 44.—*Non-forested ecosystem areas*
(Thousand
[Totals may not add

Non-forested ecosystems	High productivity				Moderately high productivity			
	Condition class				Condition class			
	Good	Fair	Poor	Total	Good	Fair	Poor	Total
Western Range:								
Sagebrush	3,184	1,511	65	4,760	325	19,303	2,297	21,925
Desert shrub	303	14	1	318	3,753	1,675	252	5,680
Southwestern shrubsteppe	405	264	41	710	3,331	2,377	262	5,970
Chaparral-mountain shrub	516	553	40	1,109	291	4,038	560	4,889
Pinyon-juniper	734	1,242	54	2,030	125	2,779	684	3,588
Mountain grasslands	2,913	1,656	214	4,783	9,499	2,267	634	12,400
Mountain meadows	578	524	202	1,304	364	135	123	622
Desert grasslands	992	291	48	1,331	2,464	2,621	510	5,595
Annual grasslands	11	----	----	11	805	227	----	1,032
Alpine[1]	57	55	8	120	6	35	25	66
Total	9,693	6,110	673	16,476	20,963	35,457	5,347	61,767
Great Plains:								
Shinnery	30	24	18	72	----	----	7	7
Texas savanna	2	1	1	4	6	16	4	26
Plains grasslands	4,317	1,502	312	6,131	29,912	1,188	371	31,471
Prairie	54	119	18	191	7,207	52	75	7,334
Total	4,403	1,646	349	6,398	37,125	1,256	457	38,838
Total non-forested ecosystems	14,096	7,756	1,022	22,874	58,088	36,713	5,804	100,605

[1] Includes proximate salt flats and playas.
[2] Includes barren areas above treeline. For statistical reasons, 8 million acres of naturally barren areas above treeline were accounted for in the low productivity, poor condition class.

TABLE 45.—*Forested ecosystem areas by*
(Thousand
[Totals may not add

Forested ecosystems	High productivity				Moderately high productivity			
	Non-stocked	Seedling, sapling and pole	Saw-timber	Total	Non-stocked	Seedling, sapling and pole	Saw-timber	Total
Western Forest:								
Douglas-fir	308	2,300	5,915	8,523	161	1,058	4,618	5,837
Ponderosa pine	140	262	1,542	1,944	281	652	4,229	5,162
Western white pine	1	47	21	69	----	152	572	724
Fir-spruce	91	426	1,718	2,235	125	442	2,848	3,415
Hemlock-Sitka spruce	80	1,357	2,685	4,122	25	276	769	1,070
Larch	----	3	798	801	34	169	886	1,089
Lodgepole pine	5	43	34	82	55	633	399	1,087
Redwood	26	97	646	769	3	11	64	78
Hardwoods	196	1,459	2,001	3,656	116	723	1,222	2,061
Total	847	5,994	15,360	22,201	800	4,116	15,607	20,523
Eastern Forest:								
White-red-jack pine	1	265	442	708	11	1,025	733	1,769
Spruce-fir	8	893	431	1,332	31	1,768	1,324	3,123
Longleaf-slash pine	5	376	537	918	74	3,918	2,046	6,038
Loblolly-shortleaf pine	16	1,640	3,503	5,159	123	9,158	9,323	18,604
Oak-pine	9	989	1,892	2,890	45	4,387	4,523	8,955
Oak-hickory	37	1,646	1,856	3,539	274	10,994	9,746	21,014
Oak-gum-cypress	8	840	1,565	2,413	68	4,530	9,113	13,711
Elm-ash-cottonwood	12	674	632	1,318	76	1,896	1,612	3,584
Maple-beech-birch	69	550	637	1,256	159	2,540	2,080	4,779
Aspen-birch	31	177	3	211	112	2,008	400	2,520
Wet grasslands	287	375	11	673	753	524	113	1,390
Total	483	8,425	11,509	20,417	1,726	42,748	41,013	85,487
Total forested ecosystems	1,330	14,419	26,869	42,618	2,526	46,864	56,620	106,010

by productivity and condition class, 1970
acres)
due to rounding]

Moderately low productivity				Low productivity				Total productivity			
Condition class				Condition class				Condition class			
Good	Fair	Poor	Total	Good	Fair	Poor	Total	Good	Fair	Poor	Total
449	19,049	13,243	32,741	414	8,687	25,692	34,793	4,372	48,550	41,297	94,219
3,582	11,268	914	15,764	2,621	36,876	24,784	64,281	10,259	49,833	25,951	86,043
3,271	16,957	3,298	23,526	112	2,290	5,993	8,395	7,119	21,888	9,594	38,601
488	6,884	1,703	9,075	174	5,406	11,428	17,008	1,469	16,881	13,731	32,081
848	9,329	3,443	13,620	708	4,559	18,172	23,439	2,415	17,909	22,353	42,677
23,601	31,872	1,523	56,996	12	301	5,347	5,660	36,025	36,096	7,718	79,839
745	895	35	1,675	2	3	439	444	1,689	1,557	799	4,045
4,352	9,630	1,888	15,870	13	180	3,109	3,302	7,821	12,722	5,555	26,098
1,759	3,606	129	5,494	6	8	149	163	2,581	3,841	278	6,700
6	11	19	36	1	2	8,097	8,100	70	103	8,149	8,322
39,101	109,501	26,195	174,797	4,063	58,312	103,210	165,585	73,820	209,380	135,425	418,625
----------	1,802	41	1,843	----------	23	59	82	30	1,849	125	2,004
59	7,536	2,446	10,041	7	987	4,156	5,150	74	8,540	6,607	15,221
58,787	69,592	507	128,886	47	967	5,758	6,772	93,063	73,249	6,948	173,260
10,180	18,502	20	28,702	8	475	1,664	2,147	17,449	19,148	1,777	38,374
69,026	97,432	3,014	169,472	62	2,452	11,637	14,151	110,616	102,786	15,457	228,859
108,127	206,933	29,209	344,269	4,125	60,764	114,847	179,736	184,436	312,166	150,882	647,484

productivity and stand-size class, 1970
acres)
due to rounding]

Moderately low productivity				Low productivity				Total productivity			
Non-stocked	Seedling, sapling and pole	Saw-timber	Total	Non-stocked	Seedling, sapling and pole	Saw-timber	Total	Non-stocked	Seedling, sapling and pole	Saw-timber	Total
440	2,903	10,005	13,348	411	3,114	7,702	11,227	1,320	9,375	28,240	38,935
578	1,598	9,999	12,175	1,102	3,415	13,770	18,287	2,101	5,927	29,540	37,568
59	155	271	485	146	1,140	1,489	2,775	206	1,494	2,353	4,053
219	885	5,752	6,856	503	1,709	9,666	11,878	938	3,462	19,984	24,384
25	255	841	1,121	51	91	621	763	181	1,979	4,916	7,076
58	695	1,610	2,363	52	356	483	891	144	1,223	3,777	5,144
233	2,687	1,563	4,483	201	9,352	3,938	13,491	494	12,715	5,934	19,143
4	11	59	74	1	2	4	7	34	121	773	928
251	935	1,381	2,567	208	8,207	6,699	15,114	771	11,324	11,303	23,398
1,867	10,124	31,481	43,472	2,675	27,386	44,372	74,433	6,189	47,620	106,820	160,629
114	3,523	1,973	5,610	254	2,756	1,459	4,469	380	7,569	4,607	12,556
587	4,991	1,960	7,538	521	9,124	1,957	11,602	1,147	16,776	5,672	23,595
571	6,335	2,691	9,597	902	2,273	1,161	4,336	1,552	12,902	6,435	20,889
396	16,566	7,882	24,844	556	4,482	1,450	6,488	1,091	31,846	22,158	55,095
301	11,114	4,875	16,290	524	4,150	1,655	6,329	879	20,640	12,945	34,464
1,260	31,343	18,878	51,481	3,300	31,848	13,899	49,047	4,871	75,831	44,379	125,081
288	6,036	5,950	12,274	1,791	2,066	1,819	5,676	2,155	13,472	18,447	34,074
413	4,853	4,116	9,382	859	6,666	3,229	10,754	1,360	14,089	9,589	25,038
478	7,070	6,240	13,788	1,048	9,120	5,642	15,810	1,754	19,280	14,599	35,633
681	9,395	1,118	11,194	874	7,247	518	8,639	1,698	18,827	2,039	22,564
580	1,423	97	2,100	88	201	42	331	1,708	2,523	263	4,494
5,669	102,649	55,780	164,098	10,717	79,933	32,831	123,481	18,595	233,755	141,133	393,483
7,536	112,773	87,261	207,570	13,392	107,319	77,203	197,914	24,784	281,375	247,953	554,112

TABLE 46.—*Management strategies by ownership and ecogroup, 1970*

(Thousand acres)

[Totals may not add due to rounding]

Ownership by ecogroup	No livestock (A)	Some livestock (B)	Extensive management (C)	Intensive management (D)	Maximize livestock (E)	Exploitative (X)	Total
National Forest System:							
Eastern Forest	19,734	3,004	443	5	----------	129	23,318
Western Forest	30,135	35,864	20,718	327	----------	20	87,066
Western Range	15,009	16,596	16,524	2,576	----------	881	51,588
Great Plains	543	2,001	1,216	122	----------	19	3,903
Total	65,421	57,466	38,903	3,032	----------	1,051	165,875
Other Federal:							
Eastern Forest	8,690	156	54	2	----------	128	9,030
Western Forest	7,740	1,911	2,094	97	----------	13	11,855
Western Range	24,342	60,960	76,665	12,591	----------	4,260	178,819
Great Plains	1,355	2,494	3,102	145	----------	8	7,105
Total	42,127	65,521	81,915	12,836	----------	4,409	206,809
Non-Federal:							
Eastern Forest	205,224	40,184	31,355	9,861	2,370	72,141	361,135
Western Forest	25,529	14,444	17,519	700	1,312	2,202	61,708
Western Range	18,449	39,675	97,236	12,330	15,531	4,996	188,218
Great Plains	9,861	18,883	138,109	19,137	30,983	877	217,851
Total	259,063	113,186	284,220	42,029	50,196	80,216	828,912
All ownerships:							
Eastern Forest	233,648	43,344	31,852	9,868	2,370	72,398	393,483
Western Forest	63,404	52,220	40,331	1,125	1,312	2,235	160,629
Western Range	57,800	117,231	199,427	27,497	15,531	10,137	418,625
Great Plains	11,759	23,378	142,427	19,406	30,983	904	228,859
Total	366,611	236,174	405,039	57,897	50,196	85,676	1,201,596

TABLE 47.—*Management strategies by ecosystem, 1970*

(Thousand acres)

[Totals may not add due to rounding]

Ecogroup by ecosystem	No livestock (A)	Some livestock (B)	Extensive management (C)	Intensive management (D)	Maximize livestock (E)	Exploitative (X)	Total
Western Range:							
Sagebrush	3,766	22,304	55,717	8,329	2,037	2,064	94,219
Desert shrub	27,281	36,175	16,657	3,467	----------	2,461	86,043
Southwestern shrubsteppe	3,219	20,210	11,795	1,315	392	1,668	38,601
Chaparral-mountain shrub	1,963	17,083	11,431	1,000	590	13	32,081
Pinyon-juniper	8,514	5,871	21,900	3,274	769	2,346	42,677
Mountain grasslands	4,633	10,840	46,201	7,503	10,053	607	79,839
Mountain meadows	260	1,024	2,091	155	503	11	4,045
Desert grasslands	----------	3,601	19,895	1,395	874	332	26,098
Annual grasslands	4	9	4,691	1,051	313	632	6,700
Alpine[1]	8,160	111	46	4	----------	----------	8,322
Total	57,800	117,232	190,428	27,497	15,531	10,138	418,625
Western Forest:							
Douglas-fir	24,941	9,814	3,999	23	----------	157	38,935
Ponderosa pine	2,090	15,975	17,562	262	----------	1,677	37,568
Western white pine	2,656	1,396	----------	----------	----------	----------	4,053
Fir-spruce	16,975	7,408	----------	----------	----------	----------	24,384
Hemlock-Sitka spruce	7,076	----------	----------	----------	----------	----------	7,076
Larch	400	3,853	890	----------	----------	----------	5,144
Lodgepole pine	7,922	9,200	2,020	----------	----------	----------	19,143
Redwood	928	----------	----------	----------	----------	----------	928
Hardwoods	415	4,571	15,858	840	1,312	401	23,398
Total	63,405	52,220	40,332	1,125	1,312	2,235	160,629
Great Plains:							
Shinnery	22	215	809	396	546	15	2,004
Texas savanna	351	654	6,040	5,163	2,151	862	15,221
Plains grasslands	9,551	20,601	123,075	10,114	9,890	27	173,260
Prairie	1.835	1,906	12,502	3,733	18.396	----------	38,374
Total	11,759	23,378	142,428	19,406	30,983	904	228,859
Eastern Forest:							
White-red-jack pine	12,390	----------	----------	----------	----------	166	12,556
Spruce-fir	23,392	----------	----------	----------	----------	203	23,595
Longleaf-slash pine	6,311	1,962	494	174	----------	11,945	20,889
Loblolly-shortleaf pine	24,814	13,855	2,647	----------	426	13,351	55,095
Oak-pine	10,716	9,002	1,282	----------	1,944	11,518	34,464
Oak-hickory	73,544	8,044	21,208	7,703	----------	14,578	125,081
Oak-gum-cypress	24,235	21	----------	----------	----------	9,817	34,074
Elm-ash-cottonwood	10,032	4,816	5,848	1,526	----------	2,815	25,038
Maple-beech-birch	27,856	3,569	57	----------	----------	4,151	35,633
Aspen-birch	16,780	1,986	128	1	----------	3,668	22,564
Wet grasslands	2,578	82	185	464	----------	185	4,494
Total	233,648	43,345	31,852	9,869	2,370	72,399	393,483
Grand Total	366,612	236,175	405,039	57,898	50,196	85,676	1,201,596

[1] Includes barren areas above treeline.

TABLE 48.—*Animal unit month production by ownership and ecosystem, 1970*

(Thousand AUM's)

[Totals may not add due to rounding]

Ecogroup by ecosystem	National Forest System	Other Federal land	Non-Federal land	All ownerships
Western Range:				
Sagebrush	1,211	7,938	1,701	10,850
Desert shrub	13	1,433	296	1,742
Southwestern shrubsteppe	55	657	1,246	1,958
Chaparral-mountain shrub	378	647	932	1,957
Pinyon-juniper	558	498	659	1,715
Mountain grasslands	1,629	1,802	18,010	21,441
Mountain meadows	1,590	111	2,608	4,309
Desert grasslands	230	1,828	3,015	5,073
Annual grasslands		635	6,367	7,003
Alpine[1]	32	1		33
Total	5,696	15,551	34,834	56,081
Western Forest:				
Douglas-fir	423	32	168	623
Ponderosa pine	1,374	111	898	2,383
Western white pine				
Fir-spruce				
Hemlock-Sitka spruce				
Larch	47	2	16	65
Lodgepole pine	59	1	13	74
Redwood				
Hardwoods	1,431	449	5,705	7,584
Total	3,334	594	6,801	10,729
Great Plains:				
Shinnery	32	([2])	424	456
Texas savanna			5,042	5,042
Plains grasslands	967	2,423	47,064	50,454
Prairie	162	42	36,609	36,814
Total	1,161	2,465	89,140	92,767
Eastern Forest:				
White-red-jack pine				
Spruce-fir				
Longleaf-slash pine	400	15	10,803	11,218
Loblolly-shortleaf pine	344	7	6,335	6,686
Oak-pine	76	4	4,829	4,909
Oak-hickory	63	13	11,616	11,692
Oak-gum-cypress	2	2	746	750
Elm-ash-cottonwood	3	9	5,317	5,329
Maple-beech-birch	40	2	4,795	4,837
Aspen-birch	136	58	5,521	5,715
Wet grasslands		36	2,352	2,388
Total	1,064	147	52,314	53,525
Grand Total	11,255	18,757	183,090	213,102

[1] Includes barren areas above treeline.

[2] Less than 500 animal unit months.

TABLE 49.—*Average animal unit month production by strategy and ecosystem, 1970*
(AUM's per acre per year)

Ecogroup by ecosystem	Strategy					1970 average
	Some livestock (B)	Extensive management (C)	Intensive management (D)	Maximize livestock (E)	Exploitative (X)	
Western Range:						
Sagebrush	0.03	0.13	0.28	0.28	0.05	0.12
Desert shrub	.01	.05	.11	----	.01	.03
Southwestern shrubsteppe	.03	.09	.17	.08	.05	.06
Chaparral-mountain shrub	.02	.12	.21	.16	.01	.07
Pinyon-juniper	.02	.05	.14	.16	.01	.05
Mountain grasslands	.10	.28	.33	.49	.11	.29
Mountain meadows	.60	.93	2.50	2.70	.45	1.14
Desert grasslands	.03	.22	.25	.25	.01	.19
Annual grasslands	.32	.92	1.52	2.49	.46	1.05
Alpine[1]	.21	.21	.20	----	----	.21
Western Forest:						
Douglas-fir	.04	.05	.23	----	.43	.04
Ponderosa pine	.04	.09	.27	----	.08	.07
Western white pine	----	----	----	----	----	----
Fir-spruce	----	----	----	----	----	----
Hemlock-Sitka spruce	----	----	----	----	----	----
Larch	.01	.02	----	----	----	.01
Lodgepole pine	.01	.02	----	----	----	.01
Redwood	----	----	----	----	----	----
Hardwoods	.06	.34	.64	1.00	.10	.33
Great Plains:						
Shinnery	.07	.19	.26	.33	.08	.23
Texas savanna	.13	.22	.44	.61	.09	.34
Plains grasslands	.22	.31	.35	.50	.61	.31
Prairie	.40	.75	.84	1.28	----	1.01
Eastern Forest:						
White-red-jack pine	----	----	----	----	----	----
Spruce-fir	----	----	----	----	----	----
Longleaf-slash pine	.64	.64	1.56	----	.78	.77
Loblolly-shortleaf pine	.17	.21	----	7.69	.04	.22
Oak-pine	.16	.24	----	1.21	.07	.21
Oak-hickory	.26	.24	.46	----	.06	.23
Oak-gum-cypress	.14	----	----	----	.08	.08
Elm-ash-cottonwood	.20	.35	1.13	----	.23	.36
Maple-beech-birch	.84	.98	----	----	.43	.62
Aspen-birch	1.43	2.01	2.60	----	.71	.99
Wet grasslands	.92	1.54	3.93	----	1.12	2.61
Weighted average	0.11	0.25	0.44	0.90	0.22	0.26

[1] Includes barren areas above treeline.

TABLE 50.—*Herbage and browse production by ownership and ecosystem, 1970*

(Thousand tons per year)

[Totals may not add due to rounding]

Ecogroup by ecosystem	National Forest System	Other Federal land	Non-Federal land	All ownerships
Western Range:				
Sagebrush	4,209	26,931	4,700	35,840
Desert shrub	28	7,667	1,796	9,491
Southwestern shrubsteppe	119	1,345	2,061	3,526
Chaparral-mountain shrub	2,634	5,481	3,445	11,559
Pinyon-juniper	1,722	1,362	1,850	4,934
Mountain grasslands	7,239	5,275	48,343	60,858
Mountain meadows	2,794	219	2,470	5,482
Desert grasslands	358	2,479	3,643	6,481
Annual grasslands	----------	594	6,292	6,886
Alpine	88	9	----------	97
Total	19,192	51,362	74,600	145,154
Western Forest:				
Douglas-fir	7,394	1,439	7,502	16,335
Ponderosa pine	6,017	524	5,221	11,762
Western white pine	241	2	37	280
Fir-spruce	3,528	334	799	4,662
Hemlock-Sitka spruce	375	116	1,779	2,270
Larch	887	52	402	1,341
Lodgepole pine	2,038	274	451	2,763
Redwood	1	32	311	344
Hardwoods	2,578	674	9,052	12,304
Total	23,060	3,447	25,554	52,060
Great Plains:				
Shinnery	90	3	834	927
Texas savanna	5	77	8,270	8,352
Plains grasslands	2,475	5,437	83,496	91,408
Prairie	402	232	53,618	54,252
Total	2,971	5,749	146,218	154,938
Eastern Forest:				
White-red-jack pine	----------	----------	----------	----------
Spruce-fir	----------	----------	----------	----------
Longleaf-slash pine	756	497	11,019	12,272
Loblolly-shortleaf pine	592	110	7,336	8,038
Oak-pine	405	164	6,021	6,590
Oak-hickory	1,288	373	20,980	22,641
Oak-gum-cypress	17	131	1,792	1,940
Elm-ash-cottonwood	3	10	5,487	5,500
Maple-beech-birch	2,507	180	27,577	30,264
Aspen-birch	3,828	290	29,868	33,986
Wet grasslands	135	7,040	4,915	12,090
Total	9,530	8,794	114,996	133,320
Grand Total	54,753	69,352	361,368	485,472

TABLE 51.—*Wood growth and average hydrologic outputs by ecosystem, 1970*
(Average)
[Totals may not add due to rounding]

Ecogroup by ecosystem	Total net wood growth	Water yield	Quality water	Storm runoff [1]	Sediment
	Million cu. ft. per yr.	*Ac. ft. per yr.*	*Ac. ft. per yr.*	*Inches*	*Tons per yr.*
Western Range:					
Sagebrush	----------	0.18	0.18	0.09	5.41
Desert shrub	----------	----------	----------	.17	.40
Southwestern shrubsteppe	----------	----------	----------	1.07	.45
Chaparral-mountain shrub	----------	.11	.11	.84	7.86
Pinyon-juniper	607	.06	.06	.22	5.12
Mountain grasslands	----------	.62	.57	.23	1.37
Mountain meadows	----------	.82	.76	.11	.14
Desert grasslands	2	----------	----------	.37	.13
Annual grasslands	----------	.19	.19	.14	.54
Alpine	----------	2.70	2.70	.39	----------
Total	609	.24 [2]	.23 [2]	.32 [2]	2.74 [2]
Western Forest:					
Douglas-fir	2,312	1.23	1.22	.90	.36
Ponderosa pine	987	.41	.32	.01	.20
Western white pine	31	.80	.80	----------	----------
Fir-spruce	564	2.06	2.06	.11	----------
Hemlock-Sitka spruce	652	4.14	4.14	1.68	.20
Larch	178	1.79	1.78	.08	.02
Lodgepole pine	240	.28	.27	.14	.07
Redwood	178	3.84	3.84	1.72	.37
Hardwoods	339	.52	.37	.72	2.49
Total	5,480	1.10 [2]	1.05 [2]	.44 [2]	.52 [2]
Great Plains:					
Shinnery	----------	.03	.03	.62	.45
Texas savanna	----------	.15	.10	2.60	.23
Plains grasslands	----------	.02	----------	.49	1.15
Prairie	----------	.32	.13	.99	1.40
Total	----------	.08 [2]	.03 [2]	.72 [2]	1.12 [2]
Eastern Forest:					
White-red-jack pine	446	1.20	1.20	.10	----------
Spruce-fir	667	1.70	1.70	.60	----------
Longleaf-slash pine	854	1.56	1.51	3.41	----------
Loblolly-shortleaf pine	3,323	1.22	1.05	1.26	.33
Oak-pine	1,586	1.63	1.23	1.32	.77
Oak-hickory	4,054	1.11	.98	.78	.78
Oak-gum-cypress	1,555	1.30	1.21	4.80	----------
Elm-ash-cottonwood	590	.91	.78	.70	.97
Maple-beech-birch	932	1.40	1.28	.85	.10
Aspen-birch	362	.70	.70	.22	----------
Wet grasslands	----------	.87	.87	5.47	----------
Total	14,369	1.24 [2]	1.11 [2]	1.37 [2]	0.43 [2]
Grand total	20,459	0.65 [2]	0.59 [2]	6.76 [2]	1.38 [2]

[1] The amount of runoff expected for a 2-year 2-day storm for a given site.
[2] Weighted average.

TABLE 52.—*Qualitative resource*

(Average value. The numerical 5-point scale used to measure these

Ecogroup by ecosystem	Soil stability	Soil quality	Air quality	Beauty	Flexibility
Western Range:					
Sagebrush	1.71	2.22	3.59	3.23	3.04
Desert shrub	1.16	2.92	3.53	3.43	3.10
Southwestern shrubsteppe	1.17	2.85	3.14	3.52	2.92
Chaparral-mountain shrub	2.18	3.18	4.00	4.00	3.18
Pinyon-juniper	2.06	2.56	3.16	2.51	3.50
Mountain grasslands	3.14	3.69	3.76	3.08	4.54
Mountain meadows	4.03	3.83	3.83	3.53	4.49
Desert grasslands	1.85	3.84	2.96	2.15	4.55
Annual grasslands	3.09	3.11	2.91	2.00	3.76
Alpine	3.04	3.99	3.00	3.99	2.01
Weighted average	1.97	2.98	3.50	3.19	3.48
Western Forest:					
Douglas-fir	4.70	3.82	4.88	3.10	2.97
Ponderosa Pine	4.41	2.95	3.85	2.97	4.57
Western white pine	2.25	1.62	1.63	1.54	1.63
Fir-spruce	4.48	3.00	2.98	2.96	3.00
Hemlock-Sitka spruce	3.33	2.17	2.15	2.52	2.17
Larch	4.68	3.00	4.83	3.10	3.83
Lodgepole pine	4.46	3.00	4.62	3.00	3.97
Redwood	4.65	2.83	3.56	3.56	2.83
Hardwoods	3.46	4.11	4.00	4.28	4.77
Weighted average	4.27	3.28	3.98	3.15	3.69
Great Plains:					
Shinnery	2.75	2.51	3.00	3.56	3.44
Texas savanna	1.53	3.29	2.98	3.71	3.63
Plains grasslands	3.96	4.41	3.18	4.02	4.12
Prairie	3.13	2.20	3.18	3.47	2.47
Weighted average	3.65	3.95	3.17	3.90	3.81
Eastern Forest:					
White-red-jack pine	4.99	4.99	4.00	2.35	3.15
Spruce-fir	5.00	5.00	4.00	3.18	4.11
Longleaf-slash pine	3.93	4.04	2.97	2.73	3.01
Loblolly-shortleaf pine	4.47	4.49	3.99	2.41	2.54
Oak-pine	3.58	4.13	2.94	3.16	2.61
Oak-hickory	3.53	4.51	3.00	2.47	3.02
Oak-gum-cypress	4.71	4.71	3.00	3.29	2.05
Elm-ash-cottonwood	3.60	4.23	3.04	2.62	3.19
Maple-beech-birch	4.53	4.54	4.00	4.08	2.85
Aspen-birch	4.84	4.45	4.00	2.88	3.50
Wet grasslands	4.96	3.96	4.63	3.62	2.19
Weighted average	4.11	4.49	3.39	2.84	2.92
Overall weighted average	3.30	3.70	3.47	3.20	3.39

outputs by ecosystem, 1970

outputs was: 5—Excellent, 4—Good, 3—Fair, 2—Poor, and 1—Bad.)

Rare species	Non-game birds	Carnivores and raptors	Hunting	Other recreation	Depressed area impact	Cultural heritage, resident	Cultural heritage, nonresident
3.61	3.61	3.80	3.08	2.96	1.02	3.10	3.10
3.99	4.20	4.32	3.28	2.71	1.00	3.62	3.48
3.00	3.89	3.25	4.20	3.46	1.00	3.76	3.15
3.76	3.39	3.47	2.97	2.79	1.02	3.11	3.17
3.47	2.62	3.72	3.66	2.81	1.64	4.04	3.48
2.36	3.31	3.56	3.56	2.39	1.00	2.89	3.71
1.86	3.26	3.63	3.64	2.75	1.00	3.02	3.90
3.87	3.53	3.81	3.81	2.97	1.00	2.97	2.97
1.86	2.76	2.77	3.02	3.76	1.25	2.91	2.91
4.94	2.02	3.00	4.97	3.00	1.00	2.02	2.03
3.39	3.53	3.74	3.46	2.83	1.08	3.29	3.32
2.81	3.50	3.80	3.08	2.88	1.00	3.71	4.30
1.64	2.46	2.37	2.43	2.49	1.01	2.85	3.52
1.83	1.63	1.63	1.43	1.53	1.00	1.62	1.62
3.69	3.01	2.94	2.22	2.96	1.00	2.96	3.03
2.15	2.18	2.18	1.23	1.96	1.00	2.15	2.52
4.08	2.71	3.45	1.94	2.95	1.00	4.37	4.37
2.12	3.71	3.95	2.46	3.26	1.00	3.84	4.62
3.56	2.09	2.09	2.09	3.56	1.00	3.56	3.41
3.45	4.62	3.50	3.21	3.55	1.00	3.06	3.70
2.67	3.23	3.16	2.58	2.87	1.00	3.22	3.73
2.93	3.24	3.67	2.91	3.94	1.00	2.35	2.88
3.44	3.84	4.02	3.68	3.74	1.14	4.07	3.55
4.81	4.25	4.25	3.75	3.93	1.00	2.61	4.29
3.33	2.66	2.64	3.24	3.47	1.00	1.76	3.32
4.45	3.94	3.96	3.65	3.84	1.01	2.56	4.06
3.96	3.47	2.73	2.98	2.73	1.00	3.00	4.35
3.32	3.46	3.42	2.57	3.19	1.00	3.00	3.90
2.30	2.45	2.40	2.44	2.23	1.00	2.73	2.89
1.84	2.72	2.94	2.21	1.46	1.01	2.76	3.52
3.47	2.89	2.61	2.25	2.05	1.06	2.65	3.02
2.96	3.14	2.93	2.94	2.49	1.00	3.09	3.89
3.14	3.86	3.15	4.14	2.00	1.00	3.16	3.00
2.98	2.98	3.00	2.98	3.33	1.00	2.55	3.48
3.54	3.55	3.27	2.35	3.61	1.00	3.16	3.88
2.80	2.75	3.73	2.74	2.98	1.01	3.60	3.45
3.55	3.38	3.14	2.33	2.15	1.00	2.58	3.72
2.93	3.12	3.00	2.76	2.48	1.01	2.98	3.59
3.35	3.44	3.46	3.15	2.91	1.03	3.04	3.61

TABLE 53.—*Land area of forested ecosystems by ownership, timber stand-size class, and ecogroup by ecosystem, 1970*

(Thousand acres)

[Totals may not add due to rounding]

Ecogroup by ecosystem	National Forest System				Other Federal				Non-Federal				All ownerships			
	Non-stocked	Seedling, sapling and pole	Sawtimber	Total	Non-stocked	Seedling, sapling and pole	Sawtimber	Total	Non-stocked	Seedling, sapling and pole	Sawtimber	Total	Non-stocked	Seedling, sapling and pole	Sawtimber	Total
Western Forest:																
Douglas-fir	612	3,804	15,795	20,211	151	743	2,382	3,276	557	4,828	10,063	15,448	1,320	9,375	28,240	38,935
Ponderosa pine	798	2,454	15,962	19,214	88	290	1,272	1,650	1,215	3,183	12,306	16,704	2,101	5,927	29,540	37,568
Western white pine	199	1,376	1,892	3,467	-------	13	122	135	7	105	339	451	206	1,494	2,353	4,053
Fir-spruce	716	2,561	15,115	18,392	30	107	1,649	1,786	192	794	3,220	4,206	938	3,462	19,984	24,384
Hemlock-Sitka spruce	100	306	1,798	2,204	14	72	425	511	67	1,601	2,693	4,361	181	1,979	4,916	7,076
Larch	123	861	2,275	3,259	5	55	138	198	16	307	1,364	1,687	144	1,223	3,777	5,144
Lodgepole pine	289	8,458	4,780	13,527	13	2,262	306	2,581	192	1,995	848	3,035	494	12,715	5,934	19,143
Redwood	-------	-------	7	7	1	20	37	58	33	101	729	863	34	121	773	928
Hardwoods	112	3,497	3,176	6,785	32	860	768	1,660	627	6,967	7,359	14,953	771	11,324	11,303	23,398
Total	2,949	23,317	60,800	87,066	334	4,422	7,099	11,855	2,906	19,881	38,921	61,708	6,189	47,620	106,820	160,629
Eastern Forest:																
White-red-jack pine	56	1,095	347	1,498	2	70	40	112	322	6,404	4,220	10,946	380	7,569	4,607	12,556
Spruce-fir	113	1,668	394	2,175	12	130	38	180	1,022	14,978	5,240	21,240	1,147	16,776	5,672	23,595
Longleaf-slash pine	39	478	618	1,135	79	401	308	788	1,434	12,023	5,509	18,966	1,552	12,902	6,435	20,889
Loblolly-shortleaf pine	82	1,428	2,113	3,623	38	344	360	742	971	30,074	19,685	50,730	1,091	31,846	22,158	55,095
Oak-pine	16	1,089	1,116	2,221	46	371	273	690	817	19,180	11,556	31,553	879	20,640	12,945	34,464
Oak-hickory	194	3,619	3,019	6,832	44	1,009	948	2,001	4,633	71,203	40,412	116,248	4,871	75,831	44,379	125,081
Oak-gum-cypress	6	169	295	470	264	461	465	1,190	1,885	12,842	17,687	32,414	2,155	13,472	18,447	34,074
Elm-ash-cottonwood	14	168	108	290	10	138	93	241	1,336	13,783	9,388	24,507	1,360	14,089	9,589	25,038
Maple-beech-birch	35	1,431	1,229	2,695	8	86	86	180	1,711	17,763	13,284	32,758	1,754	19,280	14,599	35,633
Aspen-birch	150	1,980	224	2,354	14	152	8	174	1,534	16,695	1,807	20,036	1,698	18,827	2,039	22,564
Wet grasslands	25	-------	-------	25	1,026	1,479	227	2,732	657	1,044	36	1,737	1,708	2,523	263	4,494
Total	730	13,125	9,463	23,318	1,543	4,641	2,846	9,030	16,322	215,989	128,824	361,135	18,595	233,755	141,133	393,483
Total, forested ecosystems	3,679	36,442	70,263	110,384	1,877	9,063	9,945	20,885	19,228	235,870	167,745	422,843	24,784	281,375	247,953	554,112

APPENDIX D—BASIC STATISTICS, ALTERNATIVES

The following nine tables provide additional data for the alternatives, especially for Alternative 19. These data illustrate the type and quantity of detail available for all of the alternatives. The data used in the text are summaries of this data. Data elements and totals may not agree because of rounding of the detailed data.

TABLE 54.—*Forest-range grazed by strategy, and outputs and costs, for Alternative 19 by ecogroup*

[Totals may not add due to rounding]

Item	Unit	Ecogroup				Total
		Western Range	Western Forest	Great Plains	Eastern Forest	
Percent grazed		75	48	97	44	
Acres grazed, total	Million ac.	313.8	77.3	223.0	174.8	789.1
Management strategies						
No livestock (A)	do.	104.7	83.3	5.9	218.6	412.5
Some livestock (B)	do.	61.0	32.6	16.7	45.4	155.8
Extensive management (C)	do.	136.2	31.0	155.6	36.7	359.5
Intensive management (D)	do.	75.5	13.7	26.6	92.7	208.6
Maximize livestock (E)	do.	41.1	----------	24.1	----------	65.2
Exploitative management (X)	do.	----------	----------	----------	----------	----------
Outputs:						
Herbage	Million tons	154.7	53.5	152.4	205.5	566.1
AUM production	Millions	77.9	13.6	96.1	132.1	319.7
Animal output value	Million dol.	$ 673.3	$ 115.7	$ 807.9	$1,137.4	$2,734.3
Employment	Million manhours	93.7	12.5	86.4	81.8	274.4
Wood	Billion cu. ft.	0.6	5.6	----------	14.3	20.5
Water yield	Million ac. ft.	100.2	176.2	19.4	484.3	780.1
Water quality	do.	92.0	166.4	5.5	463.3	727.1
Storm runoff	Million inch	131.1	71.8	165.0	510.2	878.1
Sediment	Million tons	1,142.4	95.2	266.5	20.2	1,524.3
Soil stability	Qualitative [1]	2.1	4.3	3.6	4.3	3.4
Soil quality	do.	3.0	3.3	4.0	4.7	3.8
Air quality	do.	3.5	4.0	3.2	3.3	3.5
Beauty	do.	3.1	3.2	4.0	3.1	3.3
Flexibility	do.	3.4	3.7	3.9	3.3	3.5
Rare species	do.	3.4	2.9	4.4	3.0	3.4
Non-game birds	do.	3.5	3.3	4.0	3.2	3.5
Carnivores and raptors	do.	3.6	3.2	4.0	3.0	3.5
Hunting	do.	3.3	2.8	3.7	3.0	3.2
Other recreation	do.	2.7	3.0	3.9	2.8	3.0
Depressed area impact	do.	1.1	1.0	1.0	1.1	1.1
Resident cultural heritage	do.	3.0	3.2	2.5	3.1	3.0
Nonresident cultural heritage	do.	3.2	3.6	4.1	3.9	3.6
Total cost	Million dollars	235.8	48.6	234.5	523.6	1,042.5
Cost per AUM	Dollars	3.03	3.57	2.44	3.96	3.26
Cost per acre	Dollars	0.75	0.63	1.05	2.91	1.32

[1] The numerical 5-point scale used to measure these outputs was: 5—Excellent, 4—Good, 3—Fair, 2—Poor, and 1—Bad.

TABLE 55.—*Acreage grazed and ungrazed by ecosystem within ecogroup by ownership under Alternative 19*

(Thousand acres)

[Totals may not add due to rounding]

Ecogroup by ecosystem	National Forest System			Other Federal			Non-Federal			All Ownerships		
	Grazed	Ungrazed	Total	Grazed	Ungrazed	Total	Grazed	Ungrazed	Total	Grazed	Ungrazed	Total
Western Range												
Sagebrush	7,956	2,046	10,002	56,068	11,084	67,152	15,466	1,599	17,065	79,490	14,729	94,219
Desert shrub	568	4,421	4,989	30,976	24,314	55,290	9,444	16,319	25,763	40,989	45,054	86,043
Southwestern shrubsteppe	828	240	1,068	7,880	2,410	10,290	24,142	3,101	27,243	32,850	5,751	38,601
Chaparral-mountain shrub	4,146	2,594	6,740	9,675	3,108	12,783	10,413	2,145	12,558	24,234	7,847	32,081
Pinyon-juniper	6,161	4,069	10,230	8,201	9,188	17,389	10,248	4,810	15,058	24,610	18,067	42,677
Mountain grasslands	6,104	1,050	7,154	5,061	586	5,647	65,362	1,676	67,038	76,527	3,312	79,839
Mountain meadows	1,877	44	1,921	102	37	139	1,936	49	1,985	3,915	130	4,045
Desert grasslands	1,102	94	1,196	8,425	1,224	9,649	14,925	328	15,253	24,454	1,644	26,098
Annual grasslands				443	2	445	6,255		6,255	6,698	2	6,700
Alpine	172	8,116	8,288	20	14	34				192	8,130	8,322
Total	28,914	22,674	51,588	126,852	51,967	178,819	158,193	30,025	188,218	313,958	104,667	418,625
Western Forest:												
Douglas-fir	9,947	10,264	20,211	789	2,487	3,276	2,283	13,165	15,448	13,019	25,916	38,935
Ponderosa pine	17,615	1,599	19,214	1,435	215	1,650	7,983	8,721	16,704	27,033	10,535	37,568
Western white pine	698	2,769	3,467		135	135		451	451	698	3,355	4,053
Fir-spruce	3,704	14,688	18,392		1,786	1,786		4,206	4,206	3,704	20,680	24,384
Hemlock-Sitka spruce		2,204	2,204		511	511		4,361	4,361		7,076	7,076
Larch	1,667	1,592	3,259	69	129	198	681	1,006	1,687	2,418	2,727	5,144
Lodgepole pine	6,027	7,500	13,527	198	2,383	2,581	1,015	2,020	3,035	7,240	11,903	19,143
Redwood		7	7		58	58		863	863		928	928
Hardwoods	6,751	34	6,785	1,560	100	1,660	14,879	74	14,953	23,190	208	23,398
Total	46,410	40,666	87,066	4,050	7,805	11,855	26,841	34,867	61,708	77,301	83,328	160,629
Great Plains:												
Shinnery	81		81	4	2	5	1,879	39	1,918	1,963	41	2,004
Texas savanna	3	2	5	73	72	145	14,969	102	15,071	15,045	176	15,221
Plains grasslands	3,312	252	3,564	6,210	542	6,752	158,962	3,982	162,944	168,484	4,776	173,260
Prairie	236	17	253	141	62	203	37,079	839	37,918	37,456	918	38,374
Total	3,631	272	3,903	6,427	678	7,105	212,892	4,959	217,851	222,950	5,909	228,859
Eastern Forest:												
White-red-jack pine		1,498	1,498		112	112	84	10,862	10,946	84	12,472	12,556
Spruce-fir		2,175	2,175	1	179	180	105	21,135	21,240	106	23,489	23,595
Longleaf-slash pine	864	271	1,135	402	386	788	16,467	2,499	18,966	17,733	3,156	20,889
Loblolly-shortleaf pine	2,755	868	3,623	397	345	742	39,536	11,194	50,730	42,688	12,407	55,095
Oak-pine	1,409	812	2,221	358	332	690	19,386	12,167	31,553	21,153	13,311	34,464
Oak-hickory	598	6,234	6,832	204	1,797	2,001	38,228	78,020	116,248	39,030	86,051	125,081
Oak-gum-cypress	242	228	470	604	586	1,190	21,110	11,304	32,414	21,956	12,118	34,074
Elm-ash-cottonwood	36	254	290	50	191	241	12,722	11,785	24,507	12,808	12,230	25,038
Maple-beech-birch	319	2,376	2,695	22	158	180	10,222	22,536	32,758	10,563	25,070	35,633
Aspen-birch	324	2,030	2,354	53	121	174	7,085	12,951	20,036	7,462	15,102	22,564
Wet grasslands	3	22	25	298	2,434	2,732	973	764	1,737	1,274	3,220	4,494
Total	6,549	16,769	23,318	2,390	6,640	9,030	165,919	195,216	361,135	174,857	218,626	393,483
Grand Total	85,504	80,371	165,875	139,720	67,090	206,910	563,844	265,068	828,912	789,067	412,529	1,201,596

TABLE 56.—*Acreage by strategy by ownership and ecogroup under Alternative 19*

(Thousand acres)

[Totals may not add due to rounding]

Ownership by ecogroup	Strategy						Total
	No livestock (A)	Some livestock (B)	Extensive mangt. (C)	Intensive mangt. (D)	Maximize livestock (E)	Exploitative (X)	
National Forest System:							
Western Range	22,674	8,774	11,738	8,402	----------	----------	51,588
Western Forest	40,656	23,017	18,802	4,591	----------	----------	87,066
Great Plains	271	1,223	1,892	517	----------	----------	3,903
Eastern Forest	16,769	2,740	889	2,920	----------	----------	23,318
Total	80,371	35,754	33,321	16,429	----------	----------	165,875
Other Federal:							
Western Range	51,967	31,938	48,270	46,644	----------	----------	178,819
Western Forest	7,805	1,378	1,803	869	----------	----------	11,855
Great Plains	678	1,274	4,697	456	----------	----------	7,105
Eastern Forest	6,640	434	229	1,727	----------	----------	9,030
Total	67,090	35,024	55,000	49,696	----------	----------	206,810
Non-Federal:							
Western Range	30,025	20,333	76,215	20,504	41,141	----------	188,218
Western Forest	34,867	8,214	10,393	8,234	----------	----------	61,708
Great Plains	4,959	14,181	148,976	25,652	24,082	----------	217,851
Eastern Forest	195,216	42,244	35,631	88,043	----------	----------	361,135
Total	265,068	84,972	271,216	142,433	65,223	----------	828,912
All ownerships:							
Western Range	104,667	61,045	136,223	75,549	41,141	----------	418,625
Western Forest	83,328	32,609	30,999	13,694	----------	----------	160,629
Great Plains	5,909	16,678	155,566	26,625	24,082	----------	228,859
Eastern Forest	218,626	45,419	36,749	92,690	----------	----------	393,483
Total	412,529	155,751	359,537	208,558	65,223	----------	1,201,596

TABLE 57.—*Domestic grazing by ownership and ecogroup in 1970 and Alternatives 20 and 19*

(Thousand animal unit months)

[Totals may not add due to rounding]

Ownership by ecogroup	1970	Alternative		Percentage increase (1970 to Alternative 19)
		20	19	
National Forest System:				
Western Range	5,696	8,540	9,161	60.8
Western Forest	3,334	2,604	4,714	41.4
Great Plains	1,161	1,798	1,641	41.3
Eastern Forest	1,064	13,159	4,557	328.3
Total	11,255	26,101	20,073	78.3
Other Federal:				
Western Range	15,551	17,417	21,002	35.1
Western Forest	594	551	844	42.1
Great Plains	2,465	3,677	3,242	31.5
Eastern Forest	147	9,789	2,973	1,922.4
Total	18,757	31,434	28,061	49.6
Non-Federal:				
Western Range	34,834	30,918	47,687	36.9
Western Forest	6,801	5,278	8,045	18.3
Great Plains	89,140	74,135	91,177	2.3
Eastern Forest	52,315	151,786	124,610	138.2
Total	183,090	262,117	271,519	48.3
All ownerships:				
Western Range	56,081	56,875	77,850	38.8
Western Forest	10,729	8,433	13,603	26.8
Great Plains	92,766	79,610	96,060	2.4
Eastern Forest	53 526	174,734	132,140	146.9
Total	213,102	319,652	319,653	50.0

TABLE 58.—*Acres grazed, costs, and outputs in 1970 and under selected alternatives*

Item	Unit	Resource situation —1970	Now policy	Single strategy alternatives					Least cost alternatives		
				No livestock (A)	Some livestock (B)	Extensive mangt. (C)	Intensive mangt. (D)	Maximize livestock (E)	1	2	20
Area grazed	Million acres	834.9	852.0	0.0	1,176.0	1,153.0	1,161.0	1,163.0	372.1	493.4	428.7
Total costs	Million dollars	858.2	1,960.4	0.0	827.0	1,113.0	2,704.0	8,292.0	291.0	916.5	531.7
Cost per AUM	Dollars	4.03	4.25	0.0	4.49	3.51	4.75	4.77	1.31	1.99	1.66
Animal unit months	Million	213.1	461.5	0.0	184.0	317.0	566.0	1,739.0	222.6	461.6	319.7
Animal output value	Million dollars	1,687.0	4,077.5	0.0	1,200.0	2,535.0	5,098.0	15,657.0	1,805.5	3,953.8	2,666.2
Employment	Million man hrs.	195.5	386.5	0.0	142.0	281.0	456.0	1,293.0	183.8	354.0	256.5
Herbage	Million tons/yr.	486.3	699.0	462.0	472.0	524.0	725.0	1,548.0	509.0	669.8	574.3
Wood	Billion cu. ft./yr.	20.5	18.9	21.0	20.0	19.0	16.0	6.0	21.3	19.4	20.5
Water yield	Million ac. ft./yr.	780.1	773.8	773.0	743.0	718.0	730.0	746.0	779.2	781.1	778.8
Quality water	Million ac. ft./yr.	706.3	697.5	773.0	732.0	659.0	599.0	510.0	773.4	743.3	747.6
Storm runoff	Million inches	908.9	912.9	820.0	802.0	791.0	832.0	924.0	849.3	869.9	857.8
Sediment	Million tons/yr.	1,658.3	1,489.6	1,312.0	1,434.0	1,511.0	1,505.0	1,688.0	1,441.2	1,448.3	1,450.3
Soil stability	Qualitative[1]	3.3	3.3	3.5	3.3	3.2	3.1	3.2	3.5	3.4	3.4
Soil quality	do.	3.7	3.7	4.1	3.9	3.7	3.6	3.2	3.9	3.9	3.9
Air quality	do.	3.5	3.3	3.6	3.6	3.4	3.4	2.8	3.5	3.5	3.5
Beauty	do.	3.2	3.3	3.2	3.5	3.5	3.5	2.8	3.3	3.3	3.3
Flexibility	do.	3.4	3.3	3.3	3.5	3.8	3.4	1.9	3.4	3.3	3.4
Rare species	do.	3.4	3.2	3.5	3.3	3.3	3.2	1.9	3.5	3.4	3.5
Non-game birds	do.	3.4	3.2	3.6	3.5	3.6	3.2	1.7	3.6	3.5	3.6
Carnivores and raptors	do.	3.5	3.2	3.8	3.7	3.5	3.2	1.7	3.7	3.6	3.7
Hunting	do.	3.2	3.0	3.4	3.2	3.3	3.2	1.7	3.5	3.3	3.4
Other recreation	do.	2.9	3.0	3.0	3.0	3.0	3.2	2.3	2.9	2.9	3.0
Depressed area impact	do.	1.0	1.1	1.0	1.0	1.1	1.2	1.8	1.0	1.1	1.1
Resident cultural heritage	do.	3.0	3.0	3.0	3.3	3.1	2.9	2.4	2.8	2.8	2.8
Nonresident cultural heritage	do.	3.6	3.6	3.7	3.7	3.5	3.2	2.7	3.7	3.6	3.7

[1] The numerical 5-point scale used to measure the outputs was: 5—excellent, 4—good, 3—fair, 2—poor, and 1—bad.

TABLE 58.—*Acres grazed, costs, and outputs in 1970 and under selected alternatives—Continued*

Item	Unit	Constrained least cost alternatives									
		4	10	11	12	13	14	15	16	17	19
Area grazed	Million acres	389.1	868.1	857.2	882.5	900.0	900.2	807.0	720.7	529.2	789.1
Total costs	Million dollars	354.2	583.3	684.4	854.2	1,061.4	1,199.2	779.3	785.6	1,031.2	1,042.5
Cost per AUM	Dollars	1.59	2.62	2.56	2.56	2.58	2.60	2.92	2.35	2.50	3.26
Animal unit months	Million	222.4	222.5	266.9	333.9	411.9	461.4	267.0	334.0	412.0	319.7
Animal output value	Million dollars	1,833.3	1,770.2	2,183.5	2,786.0	3,503.0	3,949.4	2,261.2	2,861.4	3,586.6	2,734.3
Employment	Million man hrs.	194.4	192.7	228.0	273.3	327.1	357.7	241.6	280.0	329.2	274.4
Herbage	Million tons/yr.	518.2	517.1	541.7	589.6	639.7	669.7	535.9	568.7	611.1	566.1
Wood	Billion cu. ft./yr.	20.6	21.1	20.7	20.2	19.6	19.4	20.9	20.9	20.3	20.5
Water yield	Million ac. ft./yr.	777.8	780.5	779.6	779.6	778.9	778.9	779.1	786.5	789.0	780.1
Quality water	Million ac. ft./yr.	772.2	767.7	763.0	757.2	745.5	745.0	747.7	769.0	762.1	727.1
Storm runoff	Million inches	852.7	887.2	889.0	894.9	900.7	904.1	876.2	854.2	847.7	878.1
Sediment	Million tons/yr.	1,448.0	1,483.7	1,488.5	1,490.1	1,485.7	1,486.2	1,561.6	1,593.2	1,601.4	1,524.3
Soil stability	Qualitative [1]	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Soil quality	do.	4.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.8	3.8
Air quality	do.	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Beauty	do.	3.3	3.4	3.4	3.3	3.3	3.3	3.3	3.3	3.2	3.3
Flexibility	do.	3.4	3.5	3.5	3.5	3.4	3.4	3.5	3.6	3.5	3.5
Rare species	do.	3.5	3.4	3.4	3.3	3.3	3.3	3.3	3.4	3.5	3.4
Non-game birds	do.	3.6	3.6	3.6	3.6	3.5	3.5	3.6	3.6	3.6	3.5
Carnivores and raptors	do.	3.7	3.7	3.7	3.6	3.6	3.5	3.6	3.6	3.6	3.5
Hunting	do.	3.4	3.3	3.3	3.3	3.2	3.2	3.2	3.3	3.3	3.2
Other recreation	do.	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.1	3.0	3.0
Depressed area impact	do.	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Resident cultural heritage	do.	2.9	3.2	3.1	3.1	3.1	3.0	3.0	3.0	2.8	3.0
Nonresident cultural heritage	do.	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.9	3.7	3.6

[1] The numerical 5-point scale used to measure the outputs was: 5—excellent, 4—good, 3—fair, 2—poor, and 1—bad.

TABLE 59.—*Recommended management strategy mix by resource unit from Alternative 19, Sagebrush ecosystem by ownership*

(Thousand acres)

[Parentheses indicate the cells that would receive the initial allocation of land under unconstrained least cost analysis.]

Productivity Class	Condition	National Forest System					Other Federal					Non-Federal				
		Strategy					Strategy					Strategy				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
I (High)	Good	4	144	220	(504)		116	116	779	(1,300)						
	Fair	4	149	230	(525)		30	30	202	(339)						
	Poor		11	17	(37)											
II (Moderately high)	Good	1	34	53	(120)		3	6	40	(67)						
	Fair	6	237	364	(830)		446	894	6,187	(10,333)				1	1	3
	Poor	3	118	180	(408)		39	84	564	(899)						
III (Moderately low)	Good		8	10	(21)		10	41	135	(224)						
	Fair	1	41	52	(109)		332	1,333	4,370	(7,294)		27	275	1,742	161	(3,310)
	Poor	4	230	287	(600)		192	815	2,597	(4,119)		22	244	1,544	142	(2,444)
IV (Low)	Good		3	3	5		10	81	92	220						
	Fair	2	102	101	(220)		104	828	944	(2,269)		20	412	1,411	2,088	185
	Poor	(2,019)	969	954	57		(9,799)	3,940	4,305	619		(1,529)	319	1,093	23	64

TABLE 60.—*Recommended management strategy mix by resource unit from Alternative 19, Lodgepole pine ecosystem by ownership*

(Thousand acres)

[Parentheses indicate the cells that would receive the initial allocation of land under unconstrained least cost analysis.]

Productivity Class	Stand-size class	National Forest System					Other Federal					Non-Federal				
		Strategy					Strategy					Strategy				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
I (High)	Non-stocked						1	1	(1)				2	(2)		
	Seedling, sapling and pole	1	12	2	(14)							1	6	1	(7)	
	Sawtimber	4	1		(2)		5			(1)		19			(2)	
II (Moderately high)	Non-stocked	2	21	27									2	3		
	Seedling, sapling and pole	25	241	37	(281)		1	2		(2)		4	18	2	(20)	
	Sawtimber	252	63				18					65				
III (Moderately low)	Non-stocked	(65)	51	8			(2)	1				(58)	43	5		
	Seedling, sapling and pole	85	819	(127)	956		19	33	(1)	35		55	246	(29)	282	
	Sawtimber	(786)	297	73			(76)	3	1			(278)	32	15		
IV (Low)	Non-stocked	(60)	48	7			(5)	3				(42)	31	3		
	Seedling, sapling and pole	(3,977)	1,504	375			(2,063)	85	22			(1,125)	135	63		
	Sawtimber	(2,241)	847	211			(192)	8	2			(370)	45	21		

TABLE 61.—*Recommended management strategy mix by resource unit from Alternative 19, Plains grasslands ecosystem by ownership*

(Thousand acres)

[Parentheses indicate the cells that would receive the initial allocation of land under unconstrained least cost analysis.]

Productivity Class	Condition	National Forest System					Other Federal					Non-Federal				
		Strategy					Strategy					Strategy				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
I (High)	Good	69	214	(414)			361	995	(2,262)							
	Fair	143	441	(850)			6	19	(42)							
	Poor	32	101	24	(156)											
II (Moderately high)	Good		1	(3)	1		73	73	(809)	21		723	1,446	(24,310)	1,004	1,448
	Fair	1	46	(224)	10		68	68	(750)	19						
	Poor	1	47	82	(148)		6	7	32	(46)						
III (Moderately low)	Good						5	11	(201)	6		1,463	2,928	(50,967)	1,743	1,461
	Fair		2	(7)	1		7	14	(260)	8		1,732	3,465	(60,303)	2,062	1,730
	Poor	3	18	32	(59)		9	18	149	(198)		1	1	8	(11)	1
IV (Low)	Good						1	3	(42)	1						
	Fair		1	2			3	9	(107)	3		8	42	(730)	19	42
	Poor	3	(285)	132	13		1	(19)	13	1		53	(2,911)	1,943	121	263

TABLE 62.—*Recommended management strategy mix by resource unit from Alternative 19, Loblolly-shortleaf pine ecosystem by ownership*

(Thousand acres)

[Parentheses indicate the cells that would receive the initial allocation of land under unconstrained least cost analysis.]

Productivity Class	Stand-size class	National Forest System					Other Federal					Non-Federal				
		Strategy					Strategy					Strategy				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
I (High)	Non-stocked						1			(1)		2	5		(7)	
	Seedling, sapling and pole	8	(31)	1			6	(6)				210	532	42	(801)	
	Sawtimber	30	(243)	6			19	(24)				326	1,055	168	(1,627)	
II (Moderately high)	Non-stocked						2			(2)		33	23	2	(60)	
	Seedling, sapling and pole	33	(195)	4			44	(54)				1,445	2,586	320	(4,473)	
	Sawtimber	100	(652)	36			54	(69)				1,065	2,551	490	(4,302)	
III (Moderately low)	Non-stocked	5	7		(12)		3	1		(4)		55	117	7	(183)	
	Seedling, sapling and pole	323	15	29	(368)		66	1		(68)		5,396		2,133	(8,163)	
	Sawtimber	145	239	37	(422)		68	5		(73)		907	2,172	313	(3,496)	
IV (Low)	Non-stocked	3	22	3	(28)		11	1		(12)		63	169	3	(237)	
	Seedling, sapling and pole	182	8	18	(209)		47	1		(48)		1,463		461	(2,043)	
	Sawtimber	36	53	9	(99)		21	1		(22)		225	345	30	(606)	

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[15] Key: Numbers or letters refer to the Chapter or other area to which the individual made his principal contribution—i.e., (1) Inventory Concepts and Procedures, (2) Resource Situation—1970, (3) Demand for Outputs of the Forest-Range Environment, (WG) Working Group, (TF) Task Force.

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